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CALIFORNIA FISH AND GAME

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THE GOLDEN TROUT OF COTTONWOOD LAKES

By BRIAN CURTIS

California's "golden trout" achieved nation-wide fame in the early years of this century. In 1903 Stewart Edward White incorporated it in a novel, and in 1904 President Theodore Roosevelt sent Dr. Barton Warren Evermann to make an exploratory investigation of this fish.

Since that time, it has been propagated with success at the Mount Whitney Hatchery, it has been introduced into many of the barren lakes of the High Sierra, it has even been transplanted to England. But until the work on which this article is based was undertaken, no scientific study of it in its natural habitat had been made.

The Cottonwood Lakes are situated in Inyo County less than ten miles in a straight line southeast of Mt. Whitney, but shut off from a view of our highest peak by intervening ranges, and a long day's journey from it by trail. Their elevation is about eleven thousand feet. There are, to be exact, two series of lakes, one at the head of the South Fork, the other at the head of the main Cottonwood Creek. It is the latter which served as the principal field of this study, and which are referred to in this paper as the "Cottonwood Lakes". It is from them that eggs are obtained for the Mount Whitney Hatchery, and from them probably more golden trout are taken by anglers than from any other waters in the State. Mr. Cyril Towler of the "Golden Trout Camp" for sportsmen, located on Cottonwood Creek near the lakes, very kindly undertook to make a count of the fish caught in 1933, and his records show some five thousand trout taken from the main Cottonwood Lakes,

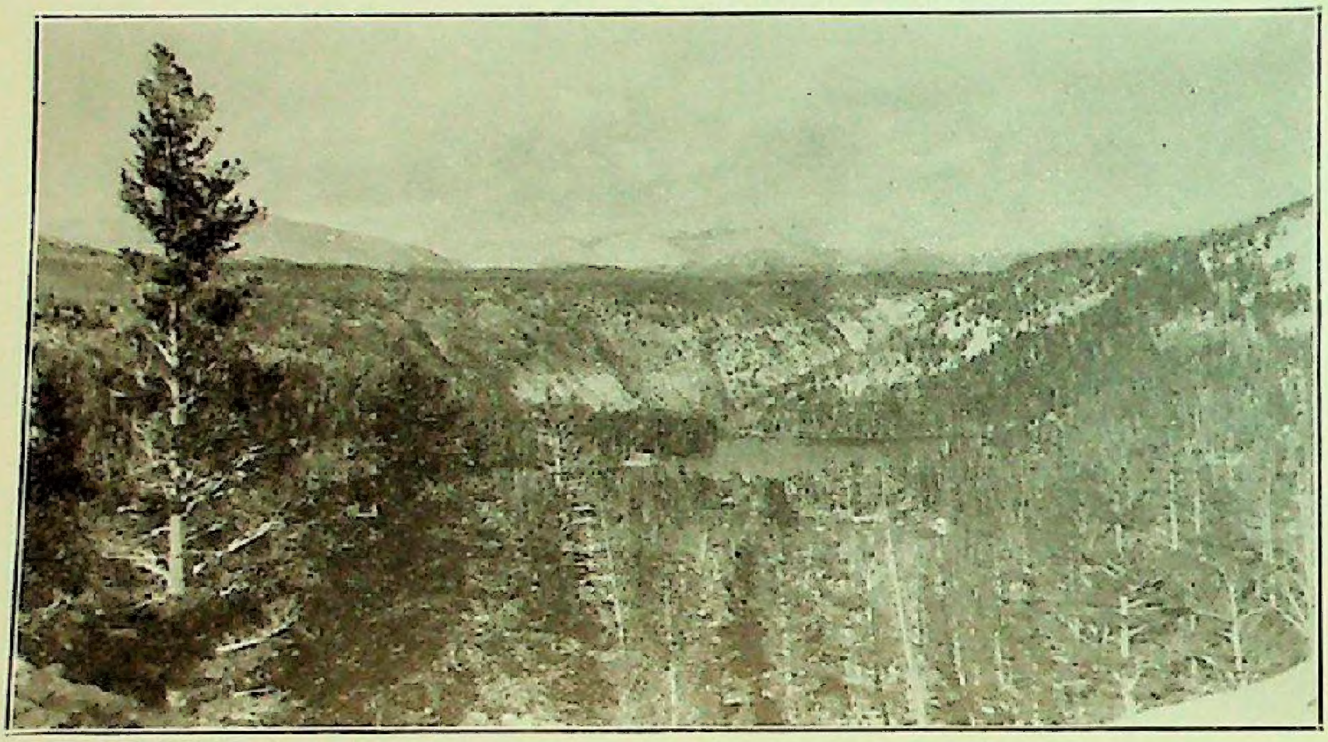


FIG. 31. Golden Trout Lake, Five Lake Basin. Photograph by E. L. Macaulay.

in addition to over two thousand from the South Fork Lakes, and an uncounted number from the Creek below the lakes.

There are six lakes in the main series, but the highest, Lake 6, is rarely visited. The other five form, as far as fish life is concerned, two systems. The upper system consists of Lakes 5 and 4, which are separated from each other by a strip of land barely a hundred yards wide. The lower system, comprising Lakes 3, 2 and 1, is over a hundred feet lower in elevation, and is cut off from the upper by falls impassable to fish. Fish can pass back and forth between Lakes 5 and 4, and between Lakes 3, 2 and 1; but they can not pass from Lake 3 into Lake 4. About half a mile below Lake 1 is another impassable falls which makes it impossible for fish in lower Cottonwood Creek to get up into the lakes. Lake 3 has been closed to fishing since 1930.

As a result of the different conditions in the two systems, the respective fish are of markedly different types. This fact must not be overlooked when considering statements made about the golden trout. Generalization is impossible. What is true of fish in Lake 4 may be

untrue of fish in Lake 3. Mature fish of Lake 4 average over 11½ inches total length. Mature fish of Lake 3 average only a little over 8 inches. This means that the mature Lake 4 fish are on the average from two-and-one-half to three times as heavy as the mature Lake 3 fish. The blurred, greyish-purple ovals along the side known as parr marks, one of the characteristic features of the golden trout, are found throughout life on the fish of the lower lakes, but the fish of Lakes 4 and 5 lose them before reaching maturity.

These and other differences would lead to the suspicion that the two systems harbored two different species were it not definitely known that one was stocked from the other and both from Cottonwood Creek. But the question of species is inescapably raised by a variation which occurs among individuals in the same system, and this is the extent to which the body is covered with dark spots. According to Dr. Evermann, this character marked the outstanding difference between *Salmo roosevelti* Evermann, found by him in Golden Trout Creek (then called Volcano Creek) and spotted only on the caudal peduncle, and *Salmo agua-bonita* Jordan, found by him in the South Fork of Kern and spotted all along the body above the lateral line.

Now, Dr. Evermann established beyond a doubt that it was from Mulkey Creek, a tributary of the South Fork of Kern, that thirteen fish were carried across the divide in a tea-pot in 1876 and planted in Cottonwood Creek which up to that time had been barren; and that in 1891 fish were taken from Cottonwood Creek, carried up above the impassable falls, and planted in the lakes. It follows that the Cottonwood Lakes fish ought to be of the same species as the South Fork of Kern fish: *Salmo agua-bonita*. And yet in any one lake it is possible to find specimens which can be classed as typical *Salmo roosevelti*, and specimens which can be classed as typical *Salmo agua-bonita*, as well as other specimens which furnish all degrees of intergradation between the two.

It seemed that the question merited further study, and accordingly trips were made from our headquarters on the Cottonwood Lakes to Mulkey Creek, to the South Fork of Kern, and to Golden Trout Creek. Fish were abundant in all these streams, and took anything from a small English dry fly to a salmon egg with avidity.

Out of 17 specimens taken in the Mulkey Creek-South Fork of Kern waters, 11 had *agua-bonita* markings, 6 *roosevelti* markings.

Out of 28 specimens taken from Golden Trout Creek at different points in what is still called Whitney Meadow, 22 had *roosevelti* marking, 6 *agua-bonita*.

Having found both types of markings in all the waters examined, the question of scale-counts was next considered. Published descriptions of the two species give a count of 200 for *roosevelti*, 160-180 for *agua-bonita*. Careful scale-counts were made of the specimens mentioned in the preceding paragraphs, and of specimens taken from the Cottonwood Lakes. An analysis showed no significant difference in scale-counts between the two types of markings.

There was no escaping the fact that, although *Salmo roosevelti* appeared to dominate in Golden Trout Creek and *Salmo agua-bonita* in the South Fork of Kern, both types did occur in both streams. The first explanation to come to mind was that the fish of each type which

occurred in the stream which is considered the habitat of the other type were specimens or descendants of specimens which passed from one body of water to the other through the man-made channels which at one time existed at a point called "The Tunnel" where the courses of the two streams approach within a few hundred yards of each other. It seems not unlikely that this was the explanation which presented itself to Dr. Evermann.

But information is available now which was not available to him: namely, that the fish of the Cottonwood Lakes, descended from fish taken from the South Fork of Kern system, also present specimens of both the *roosevelti* and the *agua-bonita* type. Now, these fish were transplanted in 1876, and it was not until 1883 that the first man-made channel between the two streams was opened. There is therefore no possibility that Golden Trout Creek fish had passed into South Fork of Kern before the transplantation was made, and that some of them, or their descendants, were included in the thirteen which made the trip over the divide in the tea-pot.

The evidence all goes to show that *Salmo roosevelti* can not, on the basis of the differentiating characters so far used, be considered a distinct species, and that it should be regarded as merely a color variation of *Salmo agua-bonita*,—retaining the latter name because of its priority; and that all fish found in Golden Trout Creek, in South Fork of Kern, and in the Cottonwood Lakes should be referred to this species.

In the Cottonwood Lakes the trout begin to run into the streams to spawn in early June, before the ice is off. It is at this time, therefore, that the eggs must be obtained for the Mount Whitney Hatchery. The fish must first be caught. This is done by placing traps at the inlet of each lake, and traps or screens at the outlet, for the golden trout have no objection to running down-stream to spawn. The eggs must then be stripped from the ripe females, and fertilized with milt from the males. These fertilized eggs must be taken down the mountain some fifteen miles on mule-back to the Chrysler and Cook Pack Station, and from there transported twenty miles by motor to the hatchery. The work is made more difficult by the climatic conditions, for at that season the Mt. Whitney region produces as much rain, hail, snow and icy wind as it does sunshine.

A large part of the data used in this study was obtained during the operation of stripping the eggs. The total length of the fish was measured in a wet, canvas-covered trough. Scales were taken for future study. The number of eggs produced by each female was calculated by a process originated by Alan C. Taft of the U. S. Bureau of Fisheries involving the total volume of each lot of eggs, the volume per egg, and a reduction factor. These data were obtained without destroying either the eggs or the fish. It was out of the question even to attempt to subject all the fish to this treatment, but with the help of Wilbur Henry of Stanford University, and of Leon A. Talbot and Clifford Harper of the Division of Fish and Game, over 450 fish were so studied.

As is usually the case in field work, the analysis of these data had to be postponed until the return to the laboratory, and the rest of the open season devoted to the collection of further material. Eggs were hatched in a basket placed in the stream in order to watch their develop-

ment under natural conditions. A two-way trap was placed between Lakes 3 and 2 to investigate the migrations of their inhabitants. Bottom and plankton samples were taken. Anglers' fish were measured and weighed, and their stomach contents preserved. Temperatures were recorded. General observations were made on the habits of the fish.

In the autumn began the study of the material collected: the statistical analysis of the relationship between the length of the fish and the number of eggs produced; the microscopic examination of scales to determine the age of the fish, the number of times they had spawned, their age at first spawning; the analysis of stomach contents, etc. From all of these elements the life history set forth in the following pages was built up. It is, therefore, a synthetic product. It is not the history of one fish or one group of fish which has been observed from the egg until death. It is the composite of observations made during one summer on fish of five different year-classes. It is built up in part from exact data, in part from hypotheses. And it applies, as has been said before, only to the specified fish with which it deals, and not to the fish of any other waters.

The golden trout of Cottonwood Lakes spawn from early June until early July, in either the inlet or the outlet of a lake, when the water temperatures range from 45 to as high as 60 degrees Fahrenheit. They may spawn for the first time at the end of either their third or fourth year. Of the fish examined in Lake 4, 40% were third-year first spawners against 60% fourth-year first-spawners; in Lake 3 they were approximately equally divided between the two categories. The average number of eggs produced by the females increases in direct proportion to the increase in total length of the fish, the average number being about 305 for a 20 cm. ($8\frac{1}{2}$ inch) fish, about 715 for a 30 cm. (12 inch) fish, about 1030 for a 37.5 cm. (15 inch) fish.* For the benefit of the statistically minded, it may be said that the coefficient of correlation is high: $.85721 \pm .00835$; and that the difference between it and the correlation ratio, $.86673 \pm .00787$, is not significant, proving the relationship to be rectilinear.

The eggs are deposited in the gravel and covered over. Their hatching period corresponds closely to that of the rainbow. At an average temperature of 58.2 degrees Fahrenheit, two sets of golden trout eggs took 20 days to hatch, while the average time required to hatch rainbow eggs at 57.2 degrees is, according to Dr. G. C. Embody of Cornell University, 20-21 days. This gives a total of 524 temperature units for the golden trout eggs, and about 517 for the rainbow, a temperature unit being one degree above freezing for one day.

The eggs referred to above, which took 20 days to hatch, were "eyed out" (the stage at which the developing eyes show as black dots through the egg membrane) at the end of 12 days.

The fry remain in the gravel when first hatched. They are helpless creatures about as thick as a small wooden toothpick and about 1.5 cm. ($\frac{2}{3}$ inch) long. They carry a comparatively huge yolk sac (0.4 cm. diameter) well forward on the belly which furnishes them with sustenance. They are so transparent that the heart can be seen

*The figures given refer to the number of eggs stripped from the female. About 7 per cent were left in the fish, so that the average total actually produced is 107 per cent of the number given.

beating. The dorsal, caudal and anal fins are still enclosed in the longitudinal fin fold. About 18 days after hatching (in the experimental fish) the yolk sac has been absorbed, the body is opaque, thickly set with dark spots and marked with the beginnings of the parr marks, the fins are free, and the fry, now nearly an inch long and fully able to navigate, emerge from the gravel.

The growth of the fry their first summer is rapid. In Lake 3 Outlet evidence shows that they double their weight every ten to twelve days. In Lake 4 Outlet the growth is not so rapid, and it is probable that the rate varies in different waters. As they increase in size the fry begin to migrate into the lakes,—a critical moment in their careers. Not all fry migrate at the same age or the same size; some may even pass the winter in the stream; but some make their appearance in the lower lakes toward the end of August, when they are about a month old and have attained a length of less than two inches.

Up to this point the development of the fish has been traced by means of actual measurements and observations of fry from eggs spawned naturally in the streams by fish which escaped the hatcherymen's traps. From here on, scale readings furnish most of the evidence. The scales of the golden trout are small, but they grow by the formation of concentric rings, and, like those of other fish of the Rainbow series, they can be "read" under the microscope. A plainly marked check shows the end of each year's growth, and a check of a different character is formed when the fish spawns.

Actual observation shows that the scale begins to form when the fry reaches a length of about 4.5 cms. (between $1\frac{3}{4}$ and $1\frac{7}{8}$ inches). In some of the fry this occurs in the first summer of their existence, but comparison of many scales from fish of all sizes shows that some of them—in which are probably to be included all of the hatchery fish, whose early growth is much slower—do not form scales until their second summer. Fortunately it is possible to differentiate between these two types of growth, as otherwise there would be danger of classifying a fish which had no first-year scale growth as one year old at the first annual check when it was really at the end of its second year. An analysis of all the scales examined showed that in Lake 4 only 23 per cent of the fish had formed scales in their first summer, whereas in Lake 3, 50 per cent had formed scales in their first summer. This can be attributed to two facts: the percentage of hatchery-planted fish is much higher in Lake 4, and the native fry grow more slowly there, due to later spawning, colder water, and probably less food in the stream.

The following table gives the average length of the fish of Lakes 3 and 4 at the end of each year. For the mature fish measured during the spawning season, the averages are based on actual measurements. For the earlier years the lengths are calculated from the scales. Statistical analysis having proved that the increase in length of the scale is proportional to the increase in length of the fish in this species, Dr. C. McLean Fraser's formula was used, which postulates that the length of the fish at the time of any previous annual check minus the unscaled length (here 4.5 cm.) is to the present length of the fish minus the unscaled length as the distance from the first ring of the scale to the

annual check in question is to the distance from the first ring to the margin.

GROWTH RATE

Average Total Length in Centimeters at the End of Each Year of Growth

	1 yr.	*2 yr.*	*3 yr.*	*4 yr.*	*5 yr.*
Lake 3 fish	5 cm.	12.7 cm.	18.8 cm.	20.8 cm.	*22 cm.
Lake 4 fish	4.1 cm.	14.6 cm.	22.9 cm.	28.5 cm.	29.4 cm.

* Only four specimens.

The weight is throughout life almost exactly proportional to the cube of the length. The average weight in grams is equal to .0107 times the average length in centimeters cubed: $w = .0107\ L^3$, which in pounds and inches reduces to $w = .000388\ L^3$. This gives an average condition factor of 38.8 in pounds and inches.

The appearance of the fish is much the same in all the five lakes at the end of their first summer: general color a silvery grey, shading from olive on the back to silver on the belly; lateral line distinct, with a rosy, irridescent wash; parr marks distinct, from 8 to 14; black spots beginning to appear on the larger specimens; fins transparent. In the second summer, during which the fish live mostly in shallow water along the shores of the lakes, the only change in their appearance is in the nature of a strengthening of all the color features and a loss of transparency in the fins, which acquire dark spots. By the end of the second year they begin to move out into deeper water, where they live henceforth. The sex organs begin to develop in the third or fourth summer, and in the following June, at the end of either the third or fourth year, the fish spawn for the first time. It is not until then that they show the bright colors typical of the Golden Trout: deep olive on the back, extending well down on the sides which, in the typical *agua-bonita*, are well spotted with black above the lateral line; caudal, dorsal and adipose fins a lighter yellowish olive spotted with black; a bright rosy band overlying the lateral line; a strip of golden below that, followed by a paler streak; and below the latter the bright cadmium of the belly. In the lower lakes the parr marks stand out plainly on all the fish, but in Lakes 4 and 5 they generally disappear by the end of the second or third year. This may be due to the rapid growth in those years. In the small outlet pond of Lake 6, several hundred feet higher than Lake 5, which is rarely fished and never used for egg supply, the fish seem, from very cursory observation, to have a slow growth, and they retain the parr marks throughout life. In general, it is noteworthy that the fish of the Cottonwood Lakes and of Cottonwood Creek are darker than those of Mulkey Creek and Golden Trout Creek—a darker version of the same color scheme—and that the fish of the lakes have pink meat, while the fish of Cottonwood Creek, South Fork of Kern and Golden Trout Creek, have white meat.

The golden trout survive spawning, but no scale was found which showed more than three spawnings. One scale indicated that its possessor was at the end of her sixth year, on her third spawning, but no other fish were found which had survived the end of their fifth year. Fish on their third spawning, however, were not infrequent.

The male, especially during the spawning season, differs from the female by a longer jaw, longer maxillary, and brighter colors, but the

distinction between the two often is not easy to make. Females outnumbered males by five to four in the spawning traps in 1933, but it is possible that these figures do not correctly represent the facts, as there seems to be a tendency of males to run earlier than females, in which case some of them might have escaped into the streams before the traps were installed.

The food of the fish of Lakes 4 and 5 consist mainly of bottom and subsurface organisms, at least until the end of August. Stomach analyses of fish from these lakes, carried on under the direction of Dr. Paul R. Needham of the U. S. Bureau of Fisheries, show the principal items of diet to be midge larvae and pupae (Chironomidae), caddis larvae and pupae—known locally as "helgrammites," and cladocera, small planktonic crustaceans like the water flea. It is stated by men long acquainted with these waters that the fish of the upper lakes do more surface feeding in the late season, and a confirmation of this may be found in the fact that the last two stomachs examined, taken on August 31, contained a high percentage of terrestrial adult insects, which must of course be taken from the surface. In general, the fish of the upper lakes were rarely seen to feed at the surface, while those of the lower lakes did so with great frequency.

Angling conditions are such as might be expected from all that has been said. Lakes 1 and 2, small and shallow, but lower and better protected from the winds than Lakes 4 and 5, offer pleasant fishing for comparatively small fish, averaging 7 to 9 inches, which may be caught without much difficulty on salmon eggs, "helgrammites," or flies, fished from the shore. Fly fishing is best in the late afternoon, when very pretty sport may be had with a dry fly. Conditions on the South Fork Lakes are very similar, both as to fish and to fishing.

Lake 3 is closed to fishing.

The upper lakes present quite a different problem to the angler. Lake 4 is over half a mile long, Lake 5 somewhat shorter. Lake 4 is over 40 feet deep, Lake 5 over 70. They lie just below Army Pass, and are swept by the winds which more often than not are blowing over the divide. On these two lakes, fishing is unprofitable before ten in the morning and after three in the afternoon. Fly fishing is unprofitable, at least before the first of September. But the man who supplies himself with salmon eggs or preferably, according to old timers, "helgrammites," and rides up to these lakes at about ten in the morning, and knows the proper spot to fish, either from shore or boat, may, before three in the afternoon when the fish stop biting, easily have a chance to fight with 20 golden trout from 9 to 15 inches long.

The stream fisherman has to content himself with smaller game. In the streams between the lakes an occasional eight inch fish can be picked up, especially in the early season, but in Cottonwood Creek below the falls they do not run so big. They are, however, extremely abundant there, and take almost any lure with eagerness.

The difference in size between the fish in Lakes 1 and 2 and those of Lakes 4 and 5 may be attributed to the difference in the size of the waters in which they live, although there are probably other reasons also, but the difference in size between the Lake 4 fish and the Lake 3 fish can not be so easily explained. Lake 3 is longer and deeper than Lake 4, and contains about the same amount of water. The fact that

mature Lake 3 fish average eight inches whereas the mature Lake 4 fish average over 11 inches is an interesting result of the interplay of man's two activities, angling and egg taking.

Lake 3 has been closed to fishing since 1930 in order to furnish an unfailing source of golden trout eggs. There has been therefore no unnatural drain on its population. Lake 3 has excellent natural spawning grounds, which at least in 1933 were successfully utilized by fish which escaped the traps. Lake 3 is the recipient during the summer of migrants from the lakes below it, as proved by experimental traps installed in the connecting streams, whereas it is impossible for fish to migrate from it to Lake 4.

Lake 4 is very heavily fished. It has poor spawning grounds, and little shelter for fry. It is not unlikely that fish migrate from it to Lake 5, while it receives no migrants from below.

The most striking resultant of these components is that in 1933 nearly five times as many fish were caught in the traps in Lake 3 as in Lake 4. If this may be taken as an indication of the total populations, Lake 3 contains almost five times as many fish as Lake 4. This fact alone would account for the difference in average size. Lake 3 approaches the condition found in the natural waters of the Golden Trout, where a long established natural balance results in a fish of small maximum size, the size of the individual being limited by the amount of food available for the whole population. Lake 4 corresponds more nearly to a new stocked barren lake, where, in the absence of other competitors, there are not enough trout to consume the total available food, and growth is therefore not limited by that factor.

The unthinking angler may rejoice that the heavy fishing drain keeps the population of Lake 4 down to a point where its inhabitants may have enough food to grow to a size which furnishes him with fine sport. But the thoughtful angler recognizes two danger signals. The first he finds in the figures of the spawning traps: a very small number of parent fish in Lake 4. The second he can see with his own eyes, for if he is observant, he will notice that at least three out of four of the fish which he catches in Lake 4 have not yet reached maturity. Three out of four are a pale, silvery color washed with a rosy iridescence, in contrast to the strong oranges and yellows of all the fish he catches in the lower lakes. In other words, many of the Lake 4 fish are caught before they have a chance to spawn even once.

All of which suggests that Lake 4, with its poor natural spawning grounds and its sparse protection for young fish, might under the present intensity of fishing, even if natural spawning were permitted there, soon become devoid of golden trout were it not constantly restocked by fry from outside sources.

PROGRESS REPORT OF TROUT FEEDING EXPERIMENTS

By J. H. WALES and R. C. LEWIS

In the course of a study of trout diseases and their relation to fish culture in California, two basic questions immediately present themselves: First, what factors tend to decrease the natural resistance of the fish? Second, what can be done when diseases appear?

The present paper is part of a progress report and concerns itself chiefly with the effect of certain foods and feeding methods upon the health of fingerling trout. While food and feeding methods are by no means the only factors which influence the health of trout they can be more easily changed than the others. Some attention has been given to the relation of space to health and growth and our findings are reported in this paper.

In experiments under way at the present time we are studying other food combinations, the effect of the amount of food fed and the effect of cleanliness upon health and growth.

The foods considered in this report were fed in essentially the same manner in which they would be fed by an average hatcheryman in a typical state hatchery. Every effort was made to care for the fish in a practical manner.

The experiments were conducted in the smallest of the five hatchery buildings at the Mt. Shasta plant (figure 32). Double banks of standard troughs were used. These have a capacity of about 79½ gallons each.

The experiments ran from November 3, 1934, to September 1, 1934. At the end of the experiment the fish averaged 2 7/16 inches in length.

In our hatcheries beef liver has been used for many years as the principal food for young trout. This has been supplemented by beef heart and by other foods to a slight extent. We wished to determine if our fish might not be made more resistant to disease by mixing other foods with the liver. Moreover, because of the high cost of liver, the difficulty encountered in preserving it fresh without expensive refrigeration, trouble in transportation, etc., it is desirable to find substitute foods which may produce satisfactory results at less expense.

It was impossible to conduct more than twelve experiments so we used beef liver as the only fresh meat, intending to use heart, etc., in future experiments.

HATCHERY CARE

Briefly, the experimental work was conducted as follows:

On November 3, 1933, 720,000 eggs were spawned and allotted to the Experimental Hatchery. These eggs were from the domestic Brown Trout or Loch Leven brood stock. This stock had never been selected, nor were the parents of our experimental eggs selected in any way. The large number of diets which we wished to use made it impossible

to deal with more than one species of fish. The reason why Loch Leven were chosen rather than eastern brook or rainbow was that during the previous season at Mt. Shasta the Loch Leven fingerlings were badly infected by Octomitus which in its intracellular stage killed a large number of fish. We wanted to determine if this disease might be eliminated by different food and feeding.

The eggs were counted by the displacement method and put into the standard California wire baskets. Five of these were given about 20,000 eggs and 18 were given about 27,000.

Each day, excepting the tender period, the eggs were washed of dirt and the dead ones removed and counted. When the eggs had reached the eyed stage they were addled by transferring them from one basket to another. In this process most of the infertile ones turned white and were removed.

Just before hatching commenced the eggs were counted again and five of the baskets given 15,000 eggs and 18 baskets each given 25,000. The loss between this time and the time of hatching was made up by appropriate additions.

As will be seen in the photograph the troughs are arranged in tandem pairs. The water from the head flume runs the length of one, drops into the lower trough and then out. One such pair was used for each experimental diet, except diet No. 3 which consisted of but an upper trough.

Hatching began on January 7, 1934, and lasted until January 18.

The troughs were kept clean during the fry period by scrubbing in the usual manner. Throughout the experiment the troughs were swept clean of loose dirt every day and scrubbed every other day. Sweeping was accomplished with a sash brush and scrubbing was done with a paint brush three inches in width. Toward the middle of the season this latter type was replaced by whisk brooms. In scrubbing an attempt was made to remove all of the slippery film that grows on the trough walls and bottom. At the time of cleaning, all dead fish were removed and counted.

We here use the term "fry" for fish between the time of hatching and the absorption of the yolk sac. The term "fingerling" is used for fish from the time they have absorbed the yolk and have begun to feed until they are a year old. This period is broken up into inch groups such as No. 1 fingerlings for fish under one inch in length, No. 2 fingerlings for fish between two and three inches in length, etc.

Feeding began on February 9. On May 25, 1300 fish were removed from those troughs originally having 25,000. This thinning was done to alleviate the crowded conditions. No such reduction was necessary in the troughs originally containing 15,000 fish. On July 6, 5000 fish were removed from the troughs originally having 25,000. On August 3, all of the troughs were thinned by 5,000. This was the only time fish were removed from the groups originally having 15,000 and the last time live fish were removed until the end of the experiments.

Once a week 100 fish were taken at random from each trough and weighed in water on a triple beam, gram balance. These weights were used in measuring weekly growth.

During the fingerling stage the average water temperature was 48° F. Minimum for the season was about 38° and the maximum 52°, the daily fluctuation being about 3°.

DESCRIPTION OF FOODS

Liver: The beef liver was received partially frozen and then thawed out before grinding.

Cost—About 10 cents per pound.

Abalone: This is a dry meal composed of abalone scraps from the packing plants at Monterey, Cal. It is ordinarily put up in three grades according to the size of particles. It contains about 5 per cent moisture. Several hours are required for it to become completely soaked with water, but in the experiments it was sufficiently soft to be fed in two hours after mixing with the other ingredients.

Cost—6 cents per pound.

Salmon Egg Meal: This is composed of dry, ground salmon eggs graded into three sizes. The moisture content is about 2 per cent. This meal requires about two hours to soak up completely. There is a decided tendency for the fine particles to separate out in the water and we are of the opinion that this is detrimental to young fingerlings.

Cost—8 cents per pound.

Balto: A canned animal food composed of ocean fish and cereal. The moisture is about 66 per cent. It has several undesirable features as a fish food. The fingerlings do not thrive particularly well on it. The cost is relatively high. There is a tendency for it to break up into fine particles and its oily nature makes it disagreeable to use. However, under certain conditions it might prove desirable, especially when it is impossible to get fresh meat for short periods of time.

Cost—6 cents per pound.

Clabbered Milk: This was fresh milk which had been clabbered with rennet in the customary manner.

Cost—2 cents per pound.

Dry Buttermilk: A fine powder which tends to separate in water. Its moisture content is about 5 per cent. The fish fed on this were badly troubled by gill disease apparently brought about by the irritation of the fine particles.

Cost—8 cents per pound.

Dry Skim Milk: This product is in the form of granules in various suitable sizes. Its moisture content is about 5 per cent. It soaks up rapidly but remains in discrete particles. The fish in the dry buttermilk experiments had become so badly troubled by gill fever that it was decided to change to dry skim milk in order to prevent serious losses. Although the death rate was not high the gills improved but little after the change was made. It appears, however, that dry skim milk is a feed worthy of further trial.

Cost—6½ cents per pound.

Alfalfa Flour: This is a fine powder made of dry alfalfa. It was thought that it might add desirable nutritional factors but this particular ingredient was unsuccessful.

Cost—2 cents per pound.

Further details relating to foods are set forth in the following table:

TABLE 1

Foods Used in Experiments

Diet No.	Ingredients	Wet weight[1]	"Dry" weight[2]	Number of fish at start
1	Liver	50%	70%	15,000
	Abalone meal	50%	30%	
2	Liver	50%	73%	15,000
	Salmon egg meal	50%	27%	
3	Liver	66⅔%	66⅔%	15,000
	Clabbered milk	33⅓%	33⅓%	
4	Liver	33⅓%	57%	25,000
	Salmon egg meal	33⅓%	21½%	
	Dry skim milk[3]	33⅓%	21½%	
5	Liver	33⅓%	57%	25,000
	Salmon egg meal	33⅓%	21½%	
	Dry skim milk[4]	33⅓%	21½%	
6	Liver	66⅔%	66⅔%	25,000
	Balto	33⅓%	33⅓%	
7	Liver	50%	73%	25,000
	Salmon egg meal	50%	27%	
8	Liver	33⅓%	56%	25,000
	Salmon egg meal	33⅓%	21%	
	Abalone meal	33⅓%	23%	
9	Liver	50%	70%	25,000
	Abalone meal	50%	30%	
10	Liver	45%	60%	25,000
	Abalone meal	45%	25%	
	Alfalfa flour	10%	15%	
11	Liver	66⅔%	66⅔%	25,000
	Clabbered milk	33⅓%	33⅓%	
12	Liver	100%	100%	25,000

[1] These percentages were computed after the ingredients had been completely water soaked.
[2] These percentages were computed before water had been added to any of the ingredients.
[3] Eggs were dipped in acriflavine.
[4] Dry skim milk was substituted for dry buttermilk on May 9th.

PREPARATION OF THE FOOD

Feeding was started just before the fish began to swim up from the bottom. From this time until they weighed 24 per oz. the liver was ground once through the $\frac{5}{64}''$ plate before mixing with the other ingredients. At this time the $\frac{1}{8}''$ plate was substituted and used for the rest of the experiment. The appropriate amounts of supplement foods were added to the ground liver together with some water. These were mixed by hand and then ground through the $\frac{5}{64}''$ plate. Later the $\frac{1}{8}''$ plate was substituted and again when the fish were larger this was replaced by the $\frac{3}{16}''$ plate. The amount of water added was a very important matter and only enough was used so that after the meals had absorbed what they could the resulting mixture was suitable to feed through the plate bottom dipper. A great deal of care was necessary in order that the foods were not made too watery, as the value of any trout food can be greatly reduced by adding too much water. The plate bottom dippers had five sizes of holes. As the fish grew it was necessary to use dippers with larger and larger holes. This is very important, as the particles of food should always be as large as can be

eaten conveniently, for if they are too small there will be considerable waste with underfed fish as a result.

The mixtures of food were allowed to stand in a cool place from 10 o'clock in the morning until 8 o'clock the following morning at which time the last of that mixing was used up. It was found that under these conditions all of the feeds remained unspoiled.

The fish were fed three times a day, at 8 and 11.30 in the morning and at 4.30 in the afternoon.

One man took entire care of the experiments throughout the period, as it would be practically impossible to get satisfactory results in any other way, there being too much difference in the feeding methods of any two men.

After the selection of a good and economical food the next thing of importance is the method of feeding, and observation seems to indicate that as much progress may be made by improving methods of feeding as by the selection of foods. It is our opinion that much of the diseased condition of fish found in our hatcheries is the result of wrong feeding rather than improper food. The importance of proper feeding is not sufficiently respected in some quarters and it appears that some hatcherymen have ample opportunity to improve their economy ratings by paying more attention to ways of feeding.

In feeding the experimental lots, a known amount of food was measured into the plate bottom dipper. This was then distributed very carefully over the surface of the entire trough. The bottom of the dipper was held just under water and then shaken sufficiently to cut off the food particles as they sank through the holes. The feeder would walk along each trough several times making sure that the food was broken just finely enough and that all of the fish had all they wanted to eat. It is our belief that one can get the best growth by feeding all that will be eaten up quickly and at the same time the fish are kept at their maximum resistance to disease. In our experience with Loch Leven fingerlings we could not feed too much from the standpoint of the fish's health. They would only eat a certain amount and any more would simply be wasted. In experiments which are under way at the present time we are attempting to determine whether underfeeding is detrimental to the health of fingerling trout.

MORTALITY

The number of eggs and fish lost during the experiments was relatively low. No serious epidemics occurred and in some of the diet groups the loss was very small.

The loss in the entire lot of 720,000 eggs was 11.4 per cent, most of which were infertile.

The loss in the entire lot of 525,000 fry was 1.8 per cent. No causes of death in these were determined.

The mortality in the fingerlings from the time feeding started until the end of the experiment, 205 days later, is divided into periods, as the fish were thinned out several times and the percentages of loss can not be lumped.

Troughs Started with 15,000 Fry

Period	*Loss*
February 9 to August 3	2.7 %
August 3 to September 1	.10%

Troughs Started with 25,000 Fry

February 9 to May 25	2.5 %
May 25 to July 6	.88%
July 6 to August 3	.71%
August 3 to September 1	.39%

In relation to disease no correlation could be seen between certain diets and the presence of motile Octomitus. All seemed to be infected to the same extent. In some feeds there was trouble from gill fever, in others it was almost entirely absent. This gill fever was caused by an undescribed bacterium. This disease was absent from the groups fed liver and abalone, those fed liver and clabbered milk and from those fed straight liver. Those fed dry buttermilk were badly infected and the other groups had the disease to a slight extent.

Salt baths were given all of the fish five times and those suffering from gill diseases were salted eight times during the season. This treatment helped considerably in keeping down the trouble.

The eggs in feed No. 4 were treated with acriflavine (1-2000 solution for 20 min.) when they were 27 days old. This has been found by Blake * to be sufficient to kill the bacterium of Furunculosis and we wished to make certain that the treatment would not injure the eggs. They produced fish which were in no way inferior to the control.

In general it was established that there was less mortality and greater growth in the upper than in the lower troughs. Fish in the troughs containing 15,000 at the start were always somewhat superior in health to those containing 25,000. It appears from the tests that it is safe to start a trough with 25,000 eggs if space for expansion is available.

The relations of various food combinations and accompanying mortality are best shown by the following graphs, figures 2 and 3.

GROWTH

Rate and other conditions of growth are best set forth in graphs as illustrated in figures 4, 5, 6 and 7. In figures 5, 6 and 7, diet No. 12, beef liver, the standard diet control, is included for comparison. It should be noted that diets No. 1, 2, and 3 in Fig. 4 are those fed to groups of 15,000 fish, whereas diet No. 12 and also the other diets represented in figures 5 and 6 were fed to groups numbering 25,000 at the start. Figure 7 illustrates the difference in growth not only in the several diets but also in the larger and smaller groups fed the same food. Thus in diets No. 1 and No. 9 the same kind of food was given to 15,000 and 25,000 fish respectively. This holds for diets No. 2 and 7, and No. 3 and 11. It will be seen that the growth is greater in each case where the smaller number of fish is fed.

* Blake, Isobel. The External Disinfection of Fish Ova, with reference to the Prophylaxis of Furunculosis. Fisheries, Scotland, Salmon Fish., 1930. No. II.

Attention is called to a feeding experiment by G. A. Coleman, Calif. Fish and Game, Vol. 16, No. 1, 1930.

Figure 4 shows that diet No. 1, consisting of liver and abalone, made the best growth. However, as we have mentioned before, it was indicated that the producing hatchery might advantageously start with 25,000 fish to a trough, therefore considerable interest centers in both growth and health comparisons in those started with that number. It will be seen that in this group the best growth was attained in the liver-abalone-salmon egg meal combination. Our only criticism of this diet is that there was a little more gill disease in it than in Nos. 9, 11, and 12. One can see that the growth attained by the liver feed (No. 12) is nearly as great as the liver and abalone mixture, but when one refers to Table 2 the difference in cost becomes apparent.

It was stated that the fish in our experiments were not given any consideration which fish in the producing hatchery might not receive.

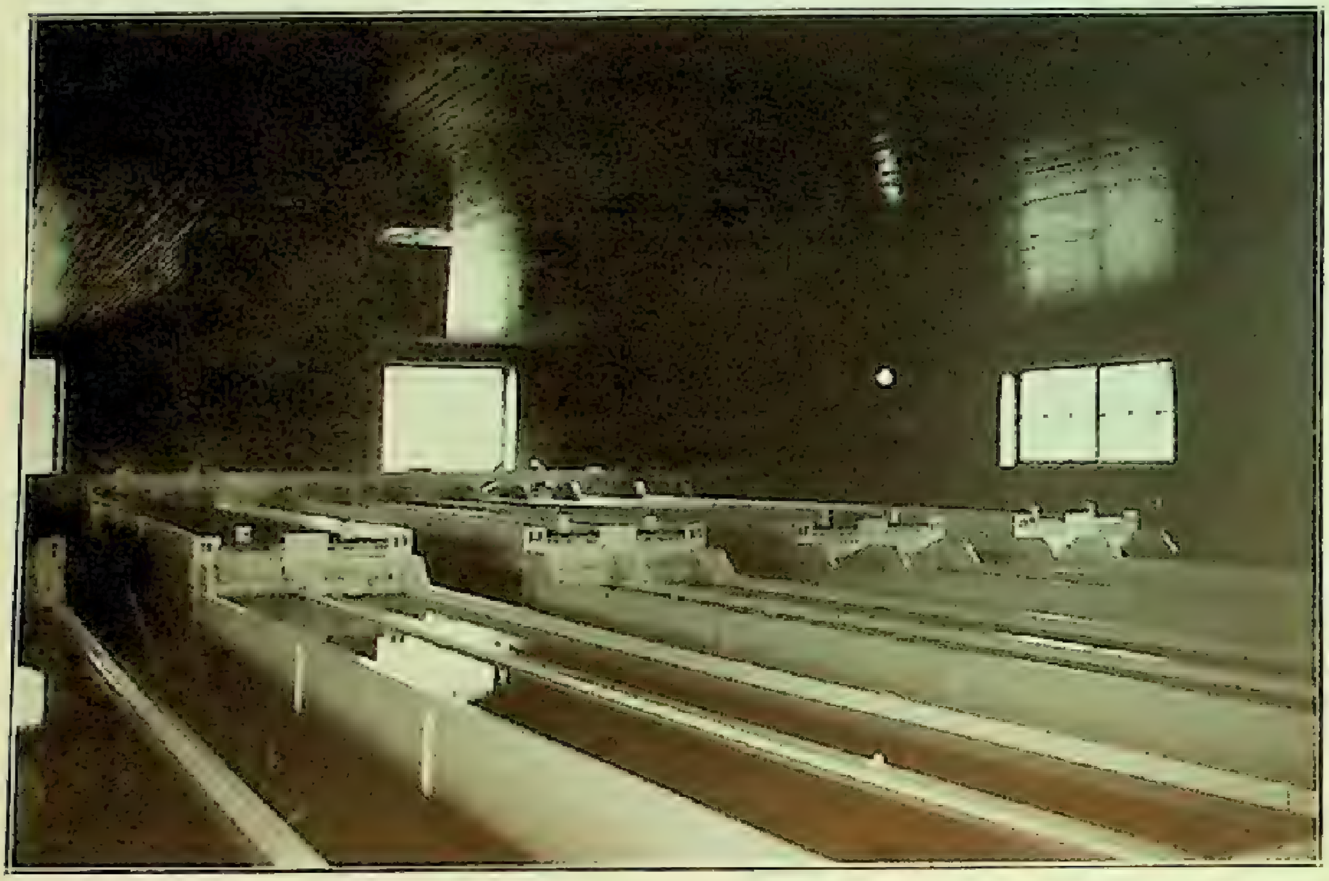


FIG. 32. Interior view of experimental hatchery. Note that the water flowing through each upper trough also flows through the adjoining lower. Thus in the total of twenty-four troughs there are twelve pairs. Each pair is considered a unit, the fish in the upper and lower halves being cared for in exactly the same manner.

An exception to this should now be made. It was desired to bring out the health qualities of the different foods and therefore we did not thin out the fish as in general practice, presuming that crowding would show up differences in the feeds. Whenever the fish became too crowded the loss rose somewhat but nothing further was learned. Crowding continued and on September 1, group No. 8 which was fed liver-salmon egg meal-abalone had 15,147 fish in the upper trough with a total weight of 117 lbs. These averaged 8.1 per oz. resulting in a distribution of 1.6 lbs. of fish to a gallon of water. The oxygen content of the water coming to the fish was about 7.1 c.c. per liter, and it eventually was brought so close to the lethal point that if the water was shut off for three minutes the fish would begin to lose their equilibrium. It was necessary

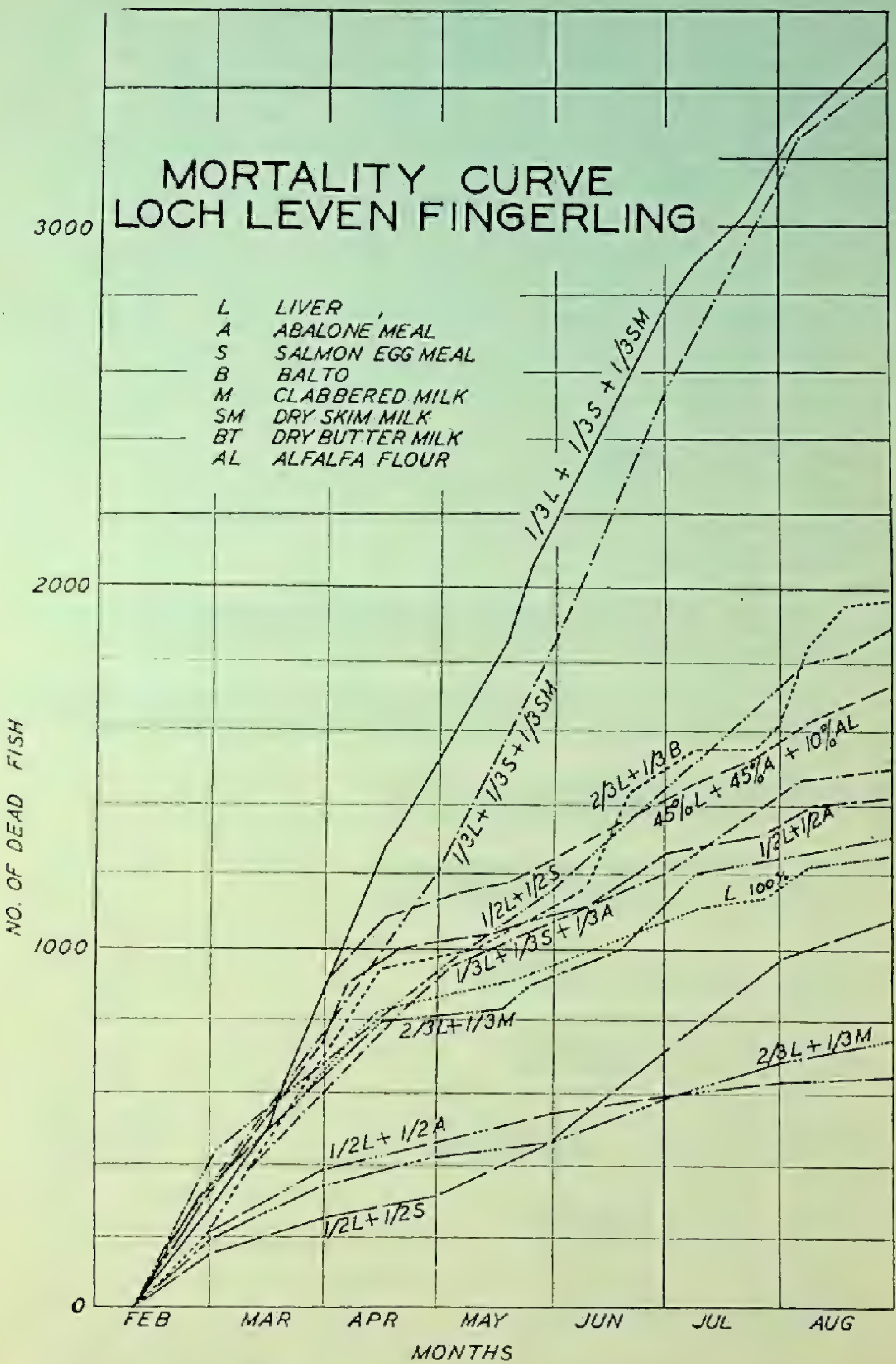


FIG. 33. The three lowest lines represent troughs of 15,000 fish at start, the rest started with 25,000 per trough. SM was substituted for BT on May 9.

to feed the upper and lower troughs of each tandem pair at different times in order that the addition of food oxidation to fish respiration did not reduce the oxygen content too much. It was apparent that a great deal of trouble would have followed if the fish had not been fed so carefully. After the fish were thinned out the mortality decreased. Some of the fluctuation in loss was due to other factors of which we know little or nothing.

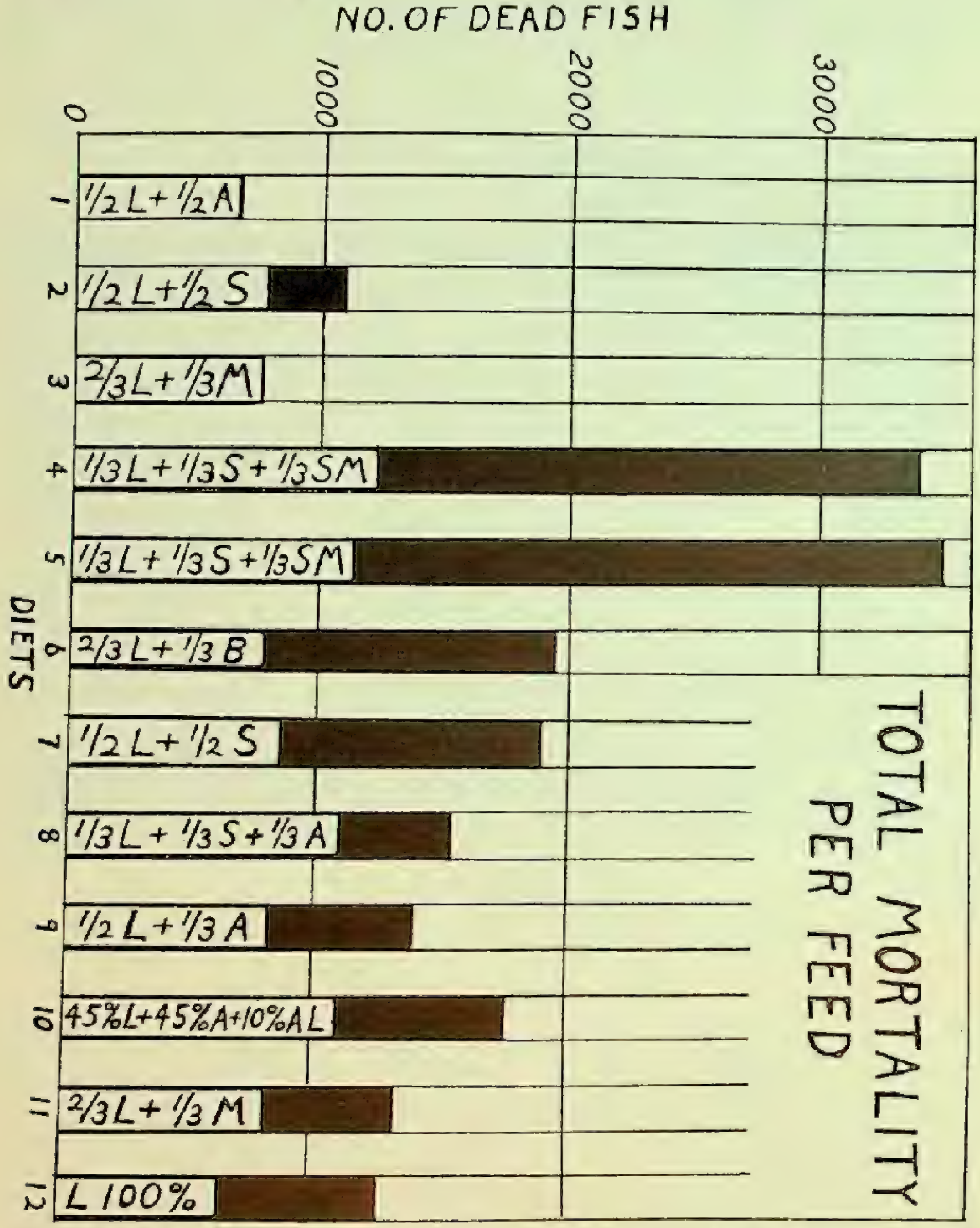


FIG. 31. First three columns, representing diets of two troughs each, were started with 15,000 fish to the trough as contrasted with the remaining groups which started with 25,000 fish per trough. L—Beef liver; A—Abalone meal; S—Salmon egg meal; B—Balto; M—Clabbered milk; SM—Dry skim milk; BT—Dry buttermilk; AL—Alfalfa flour. In diet No. 4 the eggs were dipped in acriflavine. In diet No. 5 SM was substituted for BT on May 9.

TABLE 2

Diet No.	Ingredients in dry weight percentages	Cost per pound of fish	Cost per 1,000 fish	Pounds of food to produce one pound of fish	Growth (number fish per ounce)	Mortality (per cent)
[1]1	L (70%), A (30%)	$0 21	$1 60	1.15	7.77	2.25
[1]2	L (73%), S (27%)	27	1 86	1.41	8.76	3.77
[1]3	L (66⅔%), M (33⅓%)	30	1 92	1.03	9.13	2.57
[2]4	L (57%), S (21½%), SM (21½%)	23	1 34	2.04	10.01	6.91
5	L (57%), S (21½%), SM (21½%)	24	1 35	2.76	10.24	7.13
6	L (66⅔%), B (33⅓%)	41	2 36	1.49	9.70	4.03
7	L (73%), S (27%)	30	1 91	1.58	9.55	3.87
8	L (56%), S (21%), A (23%)	19	1 27	1.32	8.86	3.09
9	L (70%), A (30%)	24	1 57	1.35	9.15	2.84
10	L (60%), A (25%), AL (15%)	25	1 43	1 48	10 03	3.58
11	L (66⅔%), M (33⅓%)	33	1 84	1.12	10.33	2.70
12	L (100%)	35	2 16	.53	9.32	2.50

[1] Diet numbers 1, 2 and 3 had 15,000 fish per trough at the start while the others had 25,000 per trough.
[2] Eggs were dipped in acriflavine.
Dry skim milk was substituted for dry buttermilk on May 9th.

L—Beef liver A—Abalone meal M—Clabbered milk SM—Dry skim milk
B—Balto S—Salmon egg meal Bt—Dry buttermilk AL—Alfalfa flour

Samples of one hundred fish were taken at random from each trough, making two samples from each diet. Total length measurements were made from these and the standard deviation computed for each diet. There was very little difference in the variation in length in the diets. The samples were probably not large enough to prove anything. The average value for the upper troughs was 4.48 mm. while for the lowers it was 4.73 mm. This of course shows a little greater variation in length of the fish in the lower troughs.

SUMMARY

Loch Leven or brown trout were used in the 1933-34 feeding experiments. The period of investigation extended from fertilization of the eggs until the fingerlings had been feeding for 203 days.

Beef liver was used as the control and in the experimental diets the following substitutes were mixed with the liver: abalone meal, salmon egg meal, dry skim milk, dry buttermilk, clabbered milk, Balto, and alfalfa flour.

Three of the diets were fed to groups of 15,000 fish and also to groups of 25,000. The other five diets were fed only to groups of 25,000 fish. Ordinary hatchery methods were used when possible.

We found that when 25,000 eggs were hatched to a trough it was necessary to thin them out more often than when 15,000 were hatched but that the health and growth of the fish in the two were not sufficiently different to warrant using the smaller number.

Beef liver alone produced fingerlings which were as satisfactory as those fed other foods, but the cost of such a diet was much higher.

The best results, everything considered, were obtained in a diet of abalone meal and liver. A diet using abalone, salmon egg and liver gave very good growth and was relatively inexpensive but the fish were troubled somewhat by gill disease. The fish fed salmon egg and liver without the abalone were affected still more by gill disease. In respect to health alone 100 per cent liver, and clabbered milk and liver were excellent but their costs were high. The other diets fell below those mentioned.

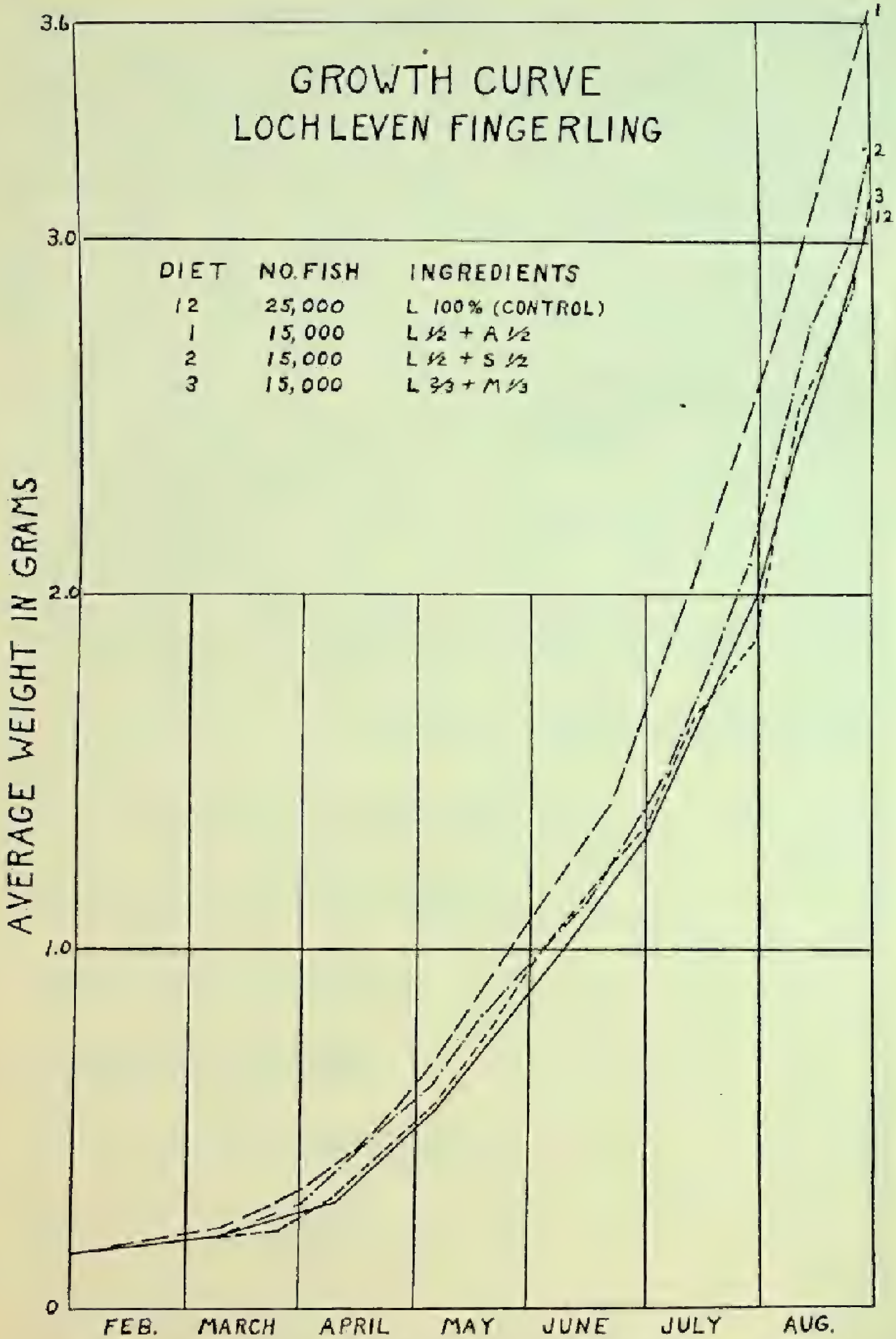
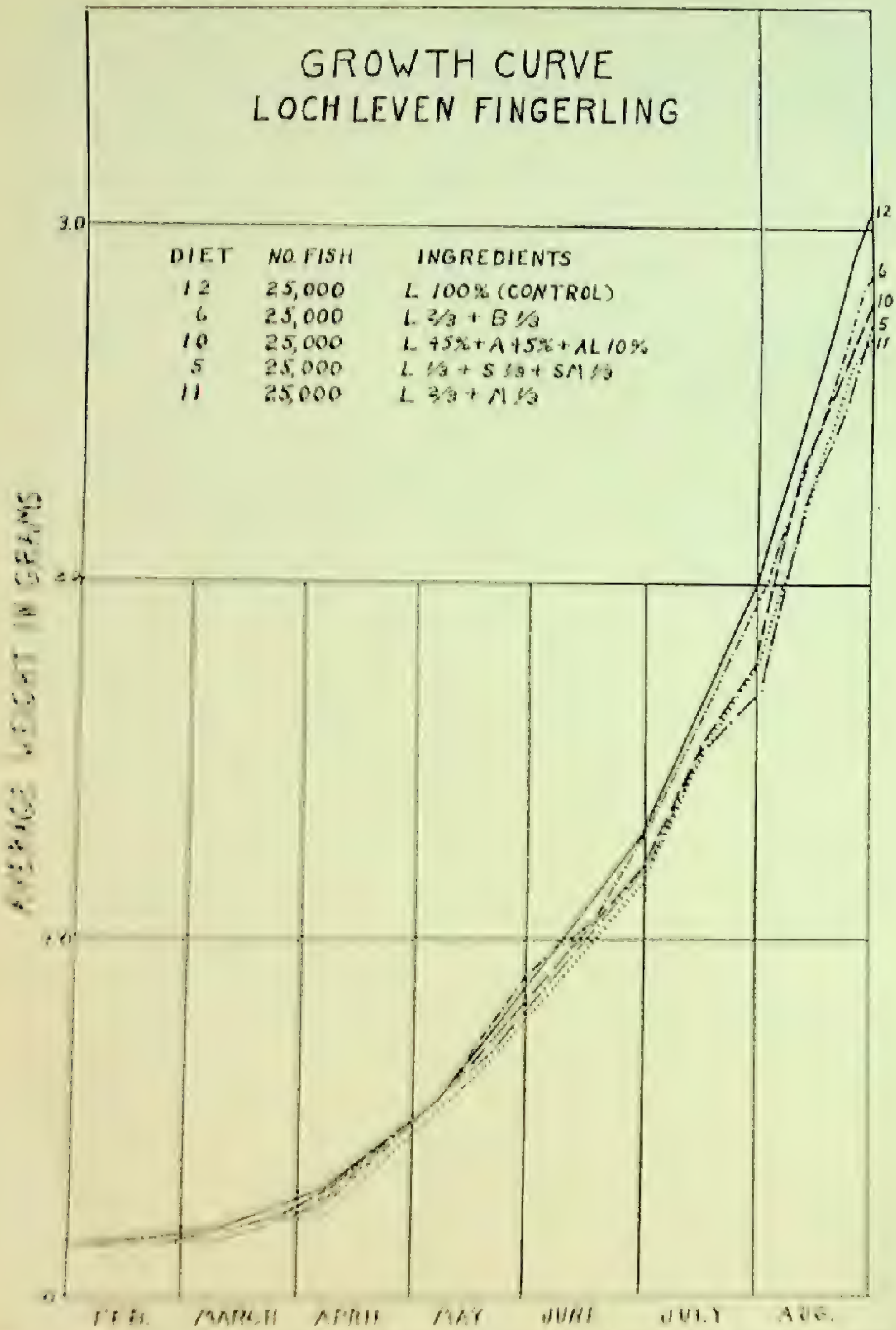


FIG. 35. In Figs. 35, 36 and 37 groups of experimental diets are compared with the beef liver control. L—Beef liver; A—Abalone meal; S—Salmon egg meal; M—Clabbered milk.

Apparently considerable money can be saved by employing substitutes for part of the fresh meat now used but the health of the fish in the California hatcheries can best be improved by a modification of feeding methods. The importance of proper feeding is much underrated.



[illegible] In Figs. 25, 26 and 27 growth of experimental diets are compared with the beef liver control. L—Beef liver; A—Abalone meal; S—Salmon egg meal; B—[illegible]; M—[illegible] milk; SM—Dry skim milk; BT—Dry buttermilk; AL—[illegible]

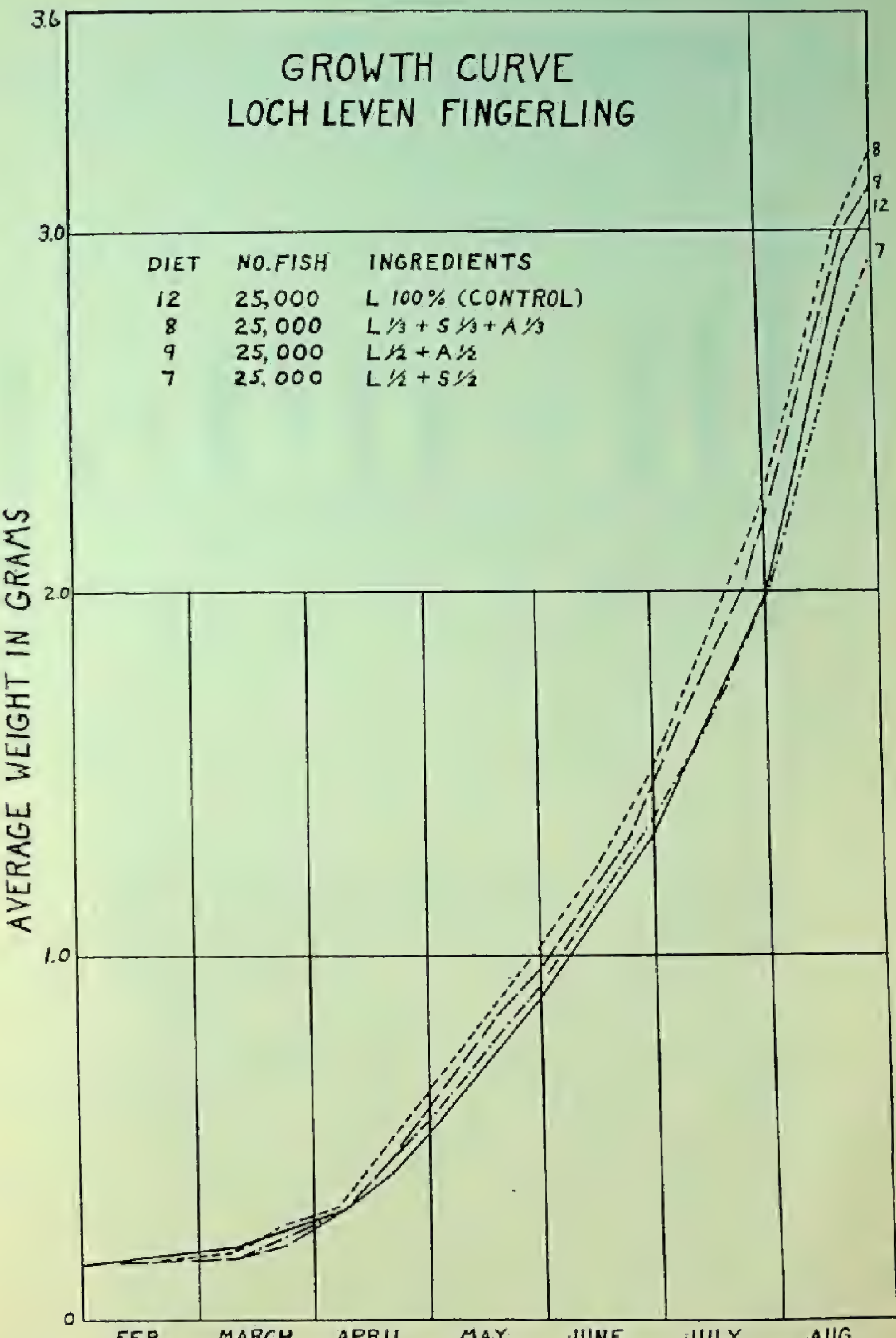


FIG. 37. In Figs. 35, 36 and 37 groups of experimental diets are compared with the beef liver control. L—Beef liver; A—Abalone meal; S—Salmon egg meal.

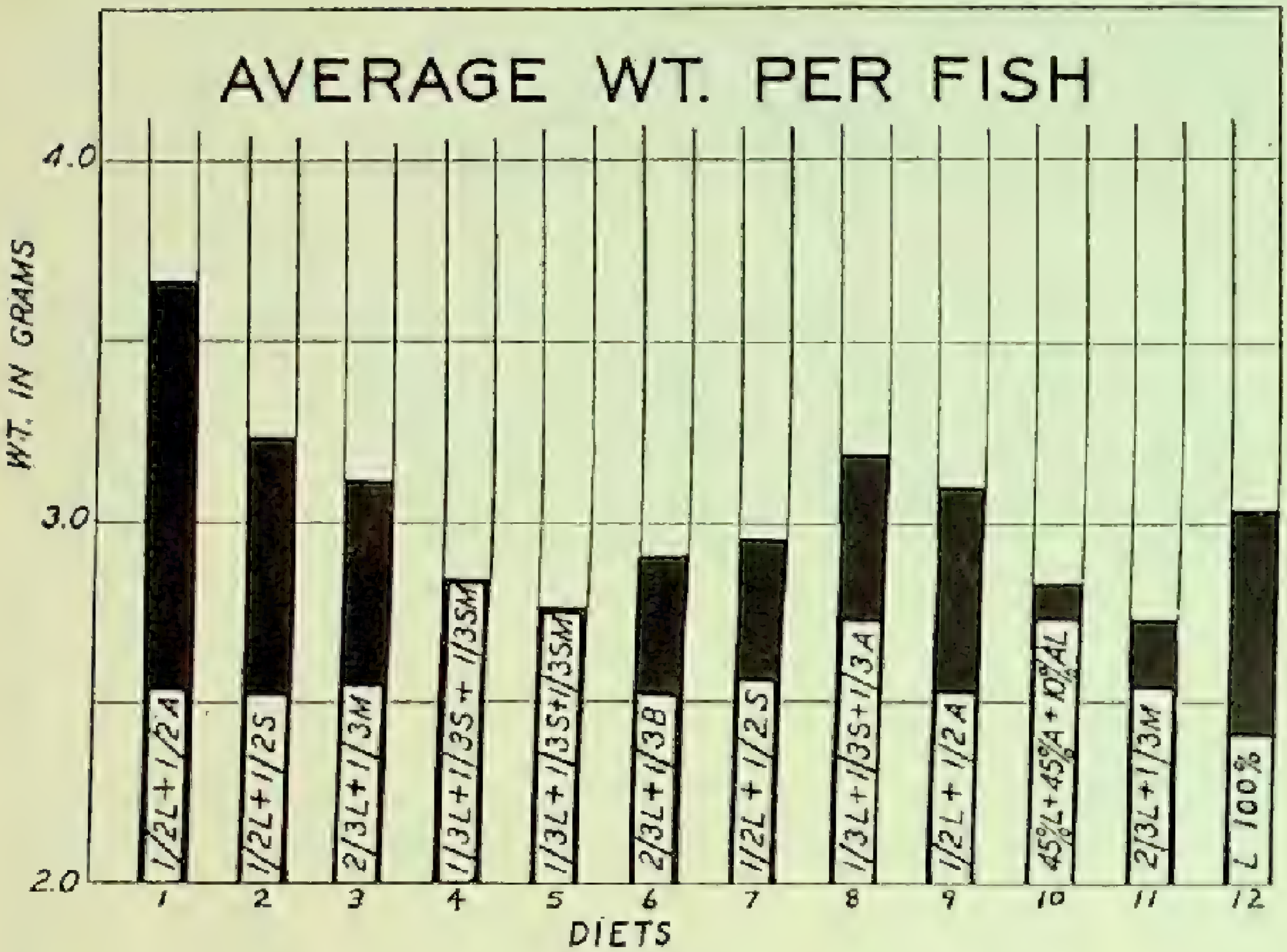


FIG. 38. First three columns, representing diets of two troughs each, were started with 15,000 fish to the trough as contrasted with the remaining groups which started with 25,000 fish per trough. L—Beef liver; A—Abalone meal; S—Salmon egg meal; B—Balto; M—Clabbered milk; SM—Dry skim milk; BT—Dry buttermilk; AL—Alfalfa flour. In Diet No. 4 the eggs were dipped in acriflavine. In diet No. 5 SM was substituted for BT on May 9.

FIG. 39. Icing and aerating at the Campbell Wharf on Echo Lake, before loading cans on pack horses.

RESTORATION AND CONSERVATION PROGRAM OF MT. RALSTON FISH PLANTING CLUB

By F. E. BROLLIAR, Chairman of Publicity

In 1925 a group of Sacramento sportsmen headed by Walter Campbell, came to the conclusion that old Mother Nature needed some help. She was finding it an impossible task to keep up with the inroads being made on the fish population in her mountain streams and lakes by a rapidly growing army of fishermen. Particularly was this true in the area near Lake Tahoe, in the American River watersheds and in the watersheds of the Rubicon and Truckee rivers.

Realizing that individuals could do little to relieve this situation, these Sacramento sportsmen decided to organize for a definite program

FIG. 40. Mt. Ralston Club pack trains carrying baby trout into the Desolation Valley region.

of cooperative work in the restoration and conservation of wild life. From that decision came the Mt. Ralston Fish Planting Club.

For ten years the club has held steadily to this unselfish program in order that the many thousands of outdoor enthusiasts who visit this area in the Sierra Nevada Mountains annually might enjoy their fishing and hunting trips to the fullest extent possible.

The club was organized primarily as a fish planting organization to work in cooperation with the California Fish and Game Commission. Each year its activities have broadened until they now include the planting of aquatic animals for fish food, establishing natural spawning areas, rearing and releasing game birds, actively working for the development of check dams for water conservation, sponsoring legislation for the protection and conservation of wild life, and the encouragement of rigid enforcement of game laws.

By Frank K. Allen
P.O. Tahoe

1934 Fish Plant—Mt. Ralston Fish Planting Club.

Season—June 24 to Sept. 6.

Desolation Valley	Eastern Brook	Rainbow	Golden
American Lake	14,000		
Cagwin "		5,000	
Cup "			2,500
Echo Lake—Upper	14,000	11,000	
" " —Lower		70,000	
Jabu Lake			2,500
Lake of the Woods		14,000	
Lost Lake	6,000		
Lucille "	14,000		
Margery "	8,000		
Medley "	62,300		
Ralston "		10,000	
Ropi "	19,000		
Tamarack "		15,000	
Toem "	4,000		
Triangle "	6,000		
Totals	147,300	125,000	5,000
Grand Total	277,300		

Glen Alpine	Eastern Brook	Rainbow	Loch Leven
Alta Morris	4,000		
Gilmore Lk.			20,000
Grass "	14,000		
Half Moon "	10,000		
Heather "			20,000
Susie "	14,000		
Totals	42,000	—	40,000
Grand Total	82,000		

Wrights Lake	Eastern Brook	Rainbow	Loch Leven
Barrette Lake	4,000		
Bryant Twin Lk.	2,000		
Dark Lk.—Lower	16,000		
Grouse Lake		6,000	
Hemlock "	4,000		
Island "	10,000		
Lake Camp 3	6,000		
Lawrence Lake	12,000		
Lost "	6,000		
Lyons "		8,000	
Maud "		10,000	
Pearl "	10,000		
Sylvia "	4,000		
Top "	6,000		
Wrights "	7,000	12,000	
Totals	87,000	36,000	
Grand Total	123,000		

American River	Eastern Brook	Rainbow	Loch Leven
Alder Creek			11,300
Aspen "	2,200		
Audrain Lake	12,000		
Big Bend			21,800
Bear's Crossing			1,400
Camp Sacramento		67,000	
Cams Bar			2,600
Cody Creek		6,000	
" Lake	8,000		
Eagle Rock			14,400
Kyburz			25,000
Scotts Camp		77,000	
Strawberry Cr.		34,000	
Totals	22,200	184,000	35,600
Grand Total	241,800		

Other Areas	Eastern Brook	Rainbow	Loch Leven
Dardanelles Lk.	14,000		
Elbert Lake	8,000		
Huckleberry "	2,200		
Round "	4,000		
Upper Truckee R.	8,000		
Totals	36,200		
Grand Total	36,200		

Total Number of Fish Planted—759,200 (Number Cans, 688)

Also 4000 Gammarus (8 cans) planted in Darrington Meadows, Tamarack, Lucille and Upper Echo Lakes, Margery and Lake of the Woods.

1934 Financial Statement.

Balance carried forward from 1933		$33.50	
Total income 1934		1299.83	1332.93
Cost of Planting Fish: Horse Hire—230 horses, 72 packers	$601.00		
Labor	80.00		
Miscel.	397.11	1,078.11	
Cost of Bird Propagation—Pens	66.10		
Feed	11.50	77.60	1155.71
Jan. 1, 1935—Balance on hand			$176.53

Chart 1.

The purpose of this article is to give in some detail, not only the history of an enthusiastically operating sportsmen's club but to tell something about its working organization in order that other clubs may be encouraged to plan more extensive operations in this big problem of conservation of our natural resources.

Any voluntary organization for this purpose must have an enthusiastic corps of officers, an equally enthusiastic group of workers on its membership roll, money for its work, and a program of activities that points into the future if it is to be really effective.

The Mt. Ralston club has been fortunate enough to have all of these things in a rather gratifying measure, hence the success it has been able to attain in its endeavors thus far.

No doubt there have been many mistakes made in carrying out some of the activities. Much has been learned in the proper handling of trout fry during the planting seasons and in effectively caring for them after the plants. Much has been learned on what varieties to plant in the various waters. Fortunately that information is a matter of very complete record which goes back to the organization of the club ten years ago. A study of these records makes it possible for the directors to plan intelligently for a new season in order to make the best possible use of the money and voluntary labor resources over which the club has command.

There is here offered a set of three charts which present in graphic form some of the past activities of the club.

Chart No. 1 represents the activities of the club during the 1934 season. Note that it gives a complete summary of each area and the individual plantings within that area along with the number and variety of trout fry planted. Analyzing the chart still further one is impressed with the amount of voluntary labor involved in the planting of more than three quarters of a million fish. The majority of plantings made in groups 1, 2, 3 and 5 were made with pack trains; two cans of fish per horse and a man to lead each horse. Some of those pack trips extended as far back as 12 miles from the unloading point of the fish trucks. None of the club members received compensation for the trip from Sacramento to the planting area or for the arduous task of assisting with the plants. This work is all done voluntarily in order that the fishing may be improved in the future.

The financial statement shows an interesting item, in that $601, or nearly half the total income for the year, was expended for horse hire to transport the fish from the trucks to the planting waters.

It may readily be seen that a record of this nature is a valuable asset to use in advertising the work of the club. This advertising is necessary in order that more people who appreciate this kind of work may affiliate themselves with the organization and help to carry on in the future. Certainly it indicates that the directors of the club at least know where they are going.

Chart No. 2 gives in graphic form the relation between the number of fish planted and the cost involved over a ten year period since the club was organized. Unfortunately it doesn't give a true picture of those costs in relation to areas planted. It is obvious that fish planted in back country by pack train are more expensive to handle than those planted from trucks in waters near highways or mountain roads. Most

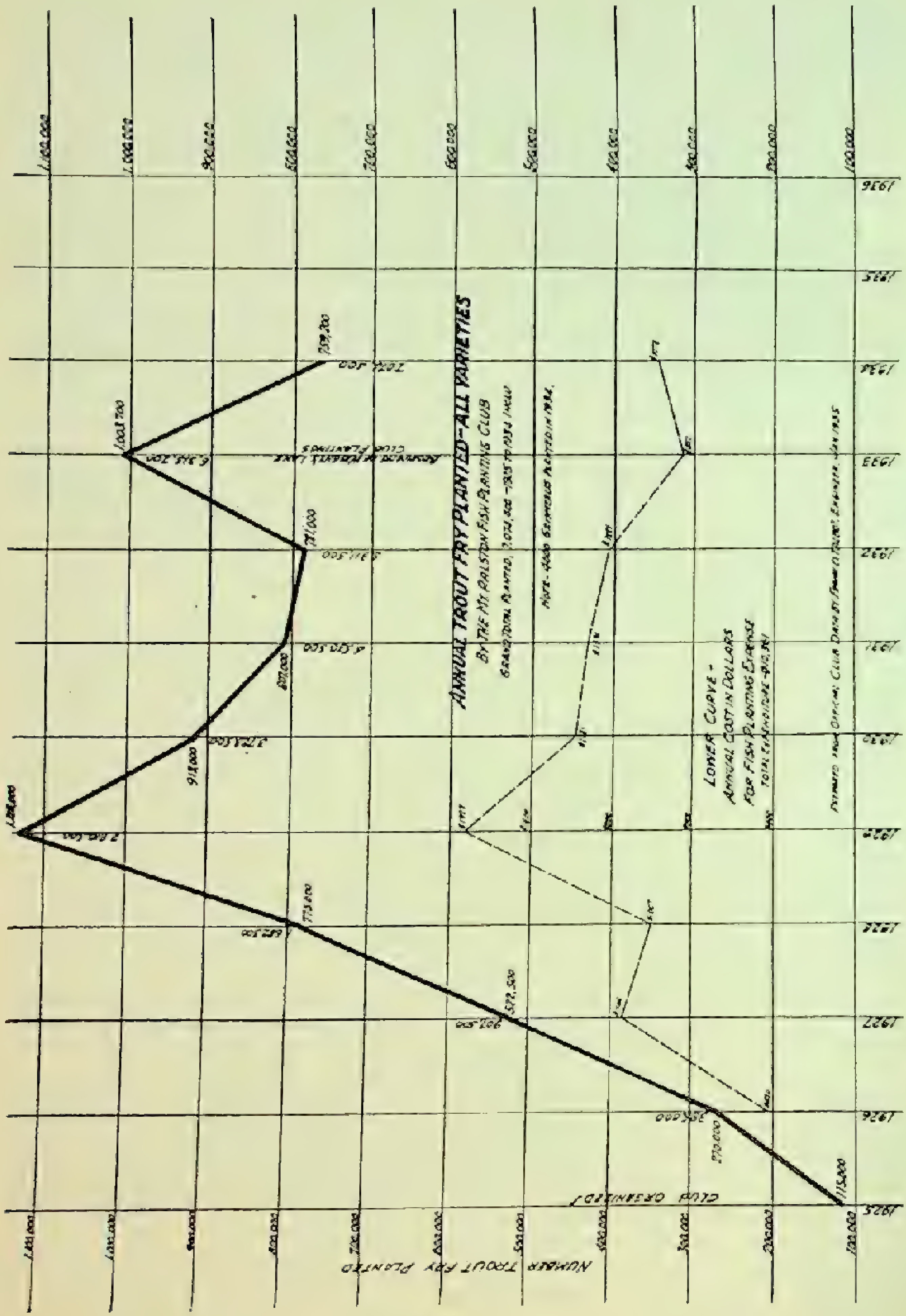

ANNUAL TROUT FRY PLANTED—ALL VARIETIES
BY THE MT. RALSTON FISH PLANTING CLUB
NUMBER TROUT FRY PLANTED
CLUB ORGANIZED
LOWER CURVE -
ANNUAL COST IN DOLLARS
FOR FISH PLANTING EXPENSE
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936

CHART 2.

of the gaps between cost and number of fish planted can be accounted for in that way.

The 1934 season shows rise in cost and reduction in numbers of fish planted due to the afore-mentioned reason and due to the fact that the Fish and Game officials adopted a new and very accurate method of counting the fish put in the cans for transportation. The contents of each can was cut to 1100 trout fry, a much smaller number than was formerly the practice. Records kept on the plantings this past season show that more cans of fish were planted than during the previous year but there were fewer fish in each can sent out to the planting crews.

Chart No. 3 presents in graphic form the comparative number of fish of each variety planted by the club over a ten year period. It tells the story of both mistakes and successful accomplishments if one but has all of the facts. Follow the line of the Black Spotted plantings and you will see a heavy concentration on this fish the first few years before it was discovered that the critter would not "stay put" in certain waters, hence his confinement to a very limited area. The same can be said for the steelhead.

The graph for the eastern brook and rainbow show a decided concentration on these two excellent fish because the results with them were very successful. They not only "stayed put" but they thrived and are increasing in numbers in all waters planted. If the proof of the pudding is in the eating, the proof of the fishing is in the catching. By trial and error along with some very excellent advice and assistance from the fish and game officials, the club members have learned a lot of valuable information about fish and their habits. The future plantings should certainly be carried on with an intelligent concentration on the activities which have proven successful. A careful record has been kept of every plant and this data is available on every one of the 75 lakes and streams the club has adopted as its particular territory.

Careful observations have been made on the development of the fish in each of the waters. Many of these waters had never been planted before and naturally some experimentation was necessary. In some cases it was necessary to plant various kinds of water insects and water plants to provide sufficient feed for the fish. In spite of some mistakes, the club has found that the planting of small trout fry may be carried out with successful results if a reasonable amount of intelligent preparation and careful handling is observed in carrying out the work.

The directors of the club interested themselves in the removal of the natural rock barrier at Salmon Falls on the American River in order that the run of steelhead up the river would not be stopped at that point. A survey was made on the feasibility of removing this barrier and through the cooperation of Mr. George D. Nordenholdt, Director of Natural Resources, this barrier was removed during the 1934 season. It is to be hoped that the steelhead will now find his way up into the more shallow waters of the American River.

In cooperation with August Bade, superintendent of the State Game Farm at Yountville, the club was instrumental in releasing 86 Reeves pheasants in the Ice House refuge on October 21, 1934; 275 ring neck pheasants in the Natoma district, 12 miles north of Sacramento, February 14, 1935, and 42 Chuccor partridges in the refuge near

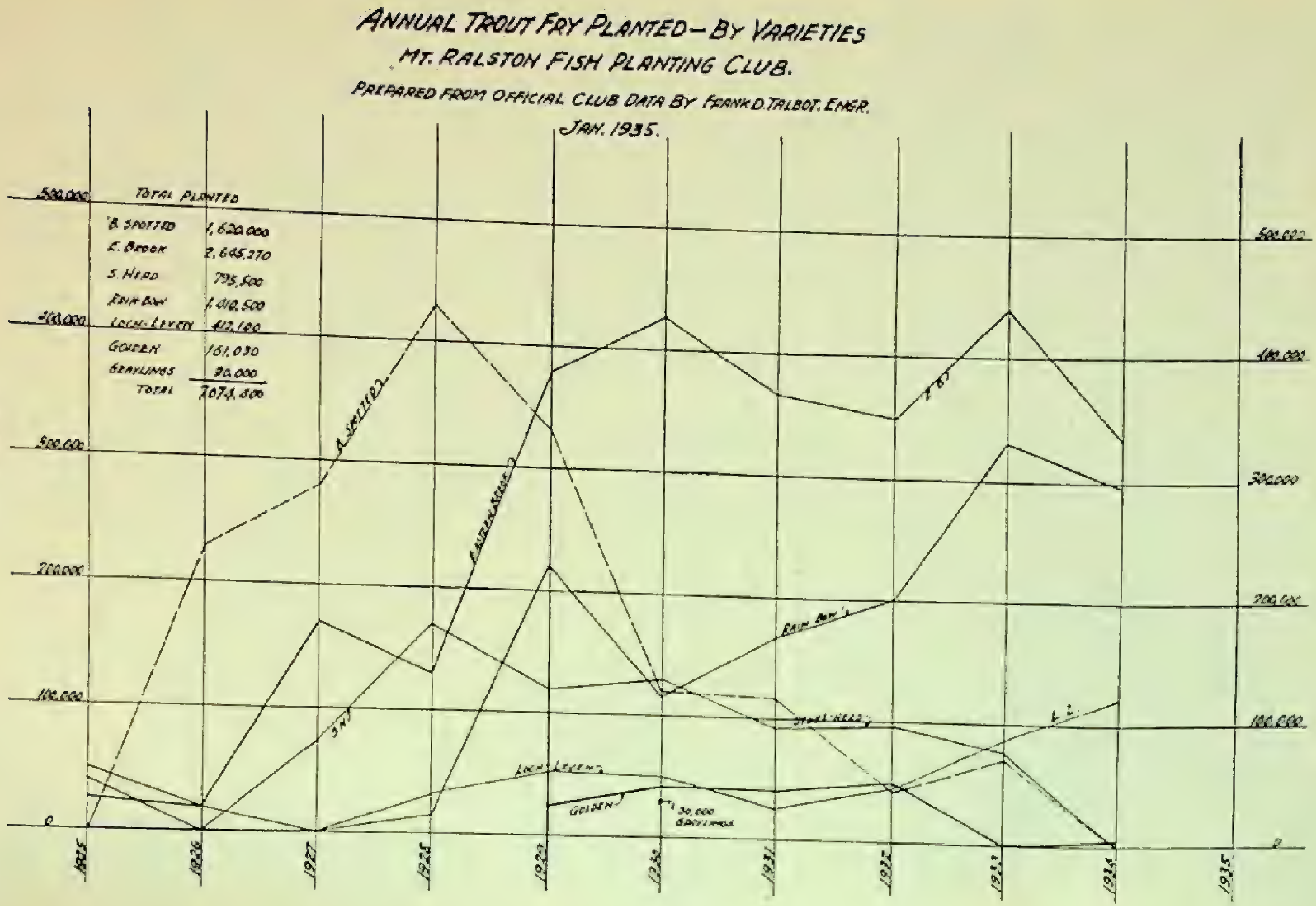

ANNUAL TROUT FRY PLANTED—BY VARIETIES
MT. RALSTON FISH PLANTING CLUB.
PREPARED FROM OFFICIAL CLUB DATA BY FRANK D. TALBOT. ENGR.
JAN. 1935.
TOTAL PLANTED
B. SPOTTED 1,620,000
E. BROOK 2,645,270
S. HEAD 795,500
RAIN BOW 1,010,500
LOCH-LEVEN 412,100
GOLDEN 161,030
GRAYLINGS 30,000
TOTAL 7,074,800
500,000
400,000
300,000
200,000
100,000
0
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
LOCH LEVENS
GOLDEN
30,000 GRAYLINGS
STEEL-HEAD
RAIN-BOW
L.L.

CHART 3.

Kyburz on February 25, 1935. Six more holding pens are being constructed near Sacramento to expand the program of bird release during the coming year. Perhaps mother nature can again be assisted in restoring more game bird life to the mountain lands, even as the fish are being restored to the mountain waters.

The Mt. Ralston Fish Planting Club is very appreciative of the excellent cooperation it has always received from the California Fish and Game Commission and all of its officials. The club takes a justifiable pride in the confidence the commission has placed in its organization and work.

SOME STREAM IMPROVEMENTS IN SEQUOIA NATIONAL PARK

By W. N. POWELL, Acting Park Naturalist

Of interest to sportsmen and conservationists is the completed project of a series of fish dams in Sequoia National Park. These have been constructed in the Lodgepole Camp area on the Marble Fork of the Kaweah River.

With the availability of labor and materials through CCC channels, 10 dams were constructed during the months of August, September

FIG. 41. Main log with part of lower logs in place.

and October. Though essentially the same, details of the work were adapted to the particular spot selected. In general this stretch of the stream is rocky, with alternating areas of sand and gravel. The stream fall is about eighty feet in the better than half a mile in which the dams are located.

As a first step, boulders and irregularities in the stream bed were dragged out of the way to make a roughly level strip across the stream bed. Then a log twenty to thirty feet long and approximately thirty inches in diameter was dragged into place across the stream at this spot. Usually its lower side lay a few inches higher than the stream bed itself. A tree or a large rock, one on each side, was then used as a side anchor.

At right angles to the main log and parallel to the stream were next placed small logs 10 feet long and 6 to 8 inches in diameter. These were dug in and extended under and past the main log a foot or more and were spaced 18 inches apart. The logs were then wired securely to the main log and the ends upstream embedded in the rocks and gravel. (Figure 41 shows this stage of the construction.) Rocks, gravel and brush were then piled against the upstream side of the main log and packed in tight. Then wire screen of square, one-inch mesh (hardware cloth) and 36 inches in width was stretched across the dam, the width of the strip slanting upstream and extending from the top of the dam to the lower logs. More sand, gravel and brush were added and packed against the screen. (Figure 42 illustrates this part of the work.)

FIG. 42. Filling with sand, the lower logs and screen in place.

A second set of small logs similar to the under set were then placed on the top side of the main log and both ends wired securely in place. Sand and gravel were then used to fill in up to the top of the dam. Both ends of the dam were then reenforced and made more secure by the addition of rocks and boulders. (Figure 43 shows completed dam.)

Depending on the fall of the stream bed, these dams formed pools from 30 to 150 feet long each grading from shallow water to a depth of three feet or more. (Figures 43 and 44 show these pools. At this point the dams were placed rather close together.)

Fish need three things to successfully survive—adequate food, safe resting and loafing places, and places to spawn. These newly constructed dams are expected to aid in better supplying the primary

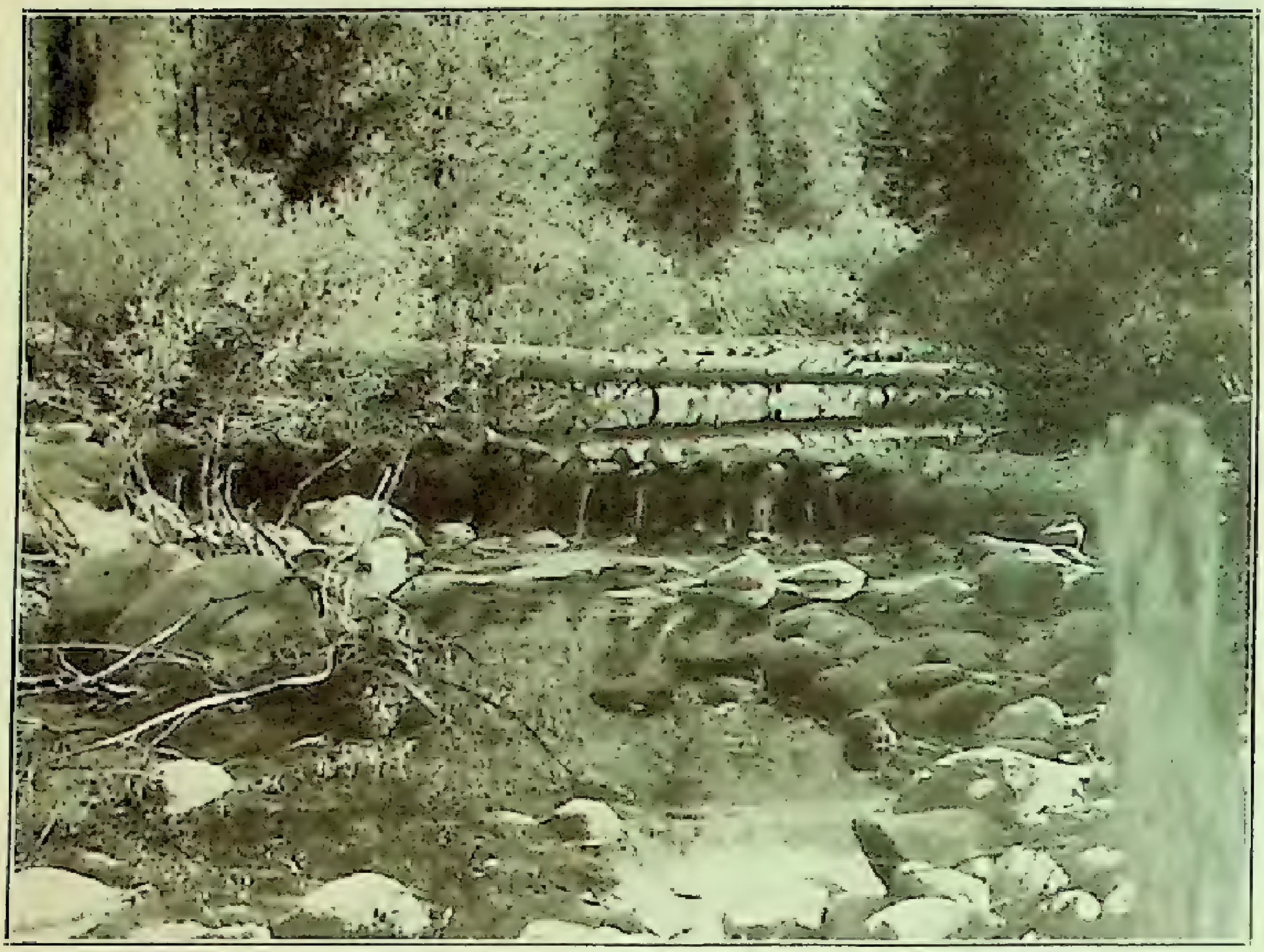


FIG. 43. The finished product, with a second dam in the background.

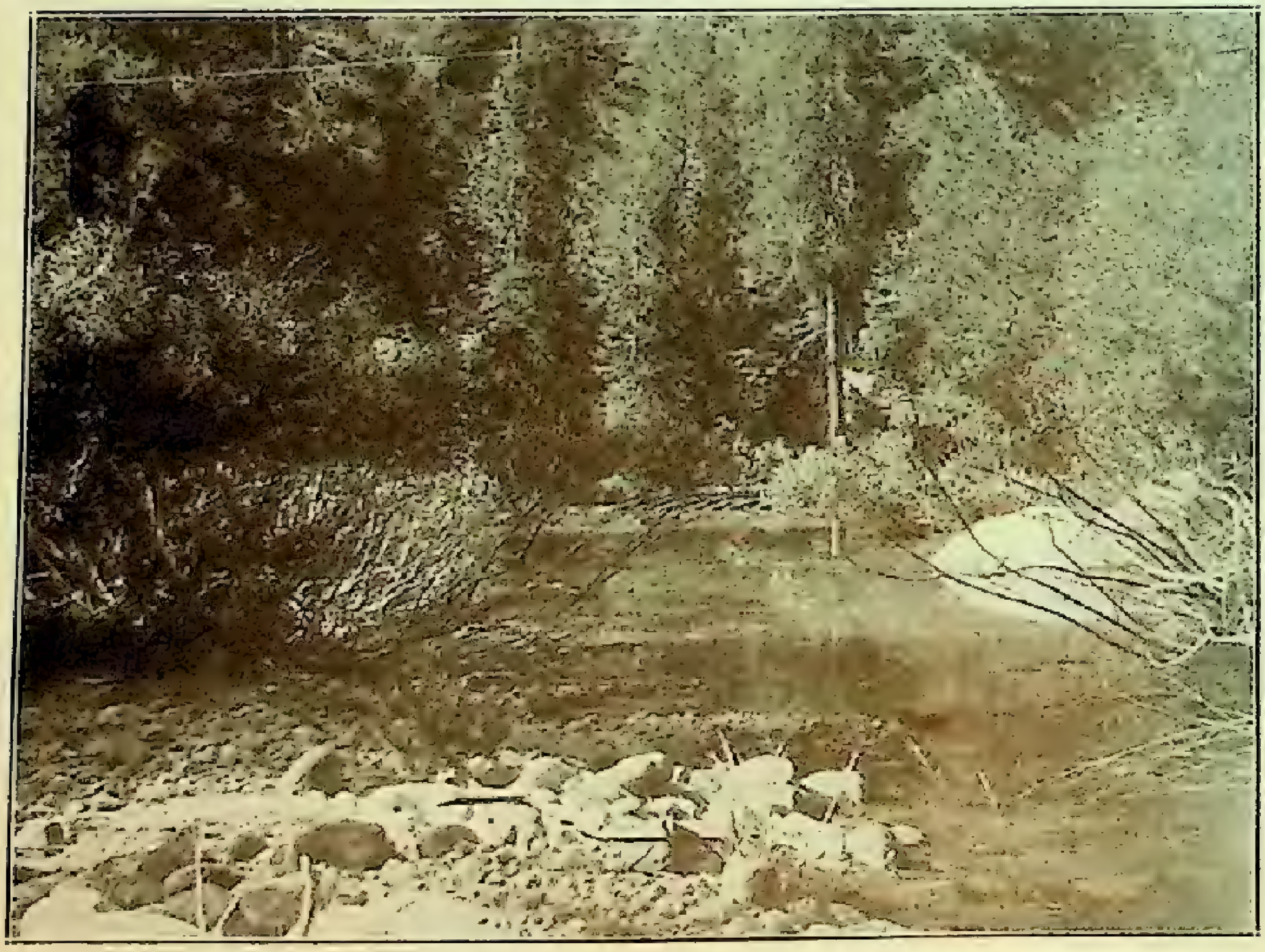


FIG. 44. One of the pools created by a dam.

needs. Of course, for trout, especially rainbow, clear, cold well aerated water with places of moderate current included are best. The Marble Fork provides this environment.

Dams back up water and increase the surface area as well as provide increased areas for the growth of tiny plant life, thus insuring a greater food supply. In backing up the water, they make it deeper, and reduce the current, in that way creating safe loafing and resting places. The spaces between the projecting small logs on the lower side of the dams will provide retreats for the small fish. The deeper water and the continuing pools even through the fall months will offer safe year around retreats for the big fish.

The dams will provide areas where sand and gravel will accumulate. California streams are especially subject to water fluctuation, high in the spring, low in the fall. These spring floods grind off the sand and gravel spawning beds, as well as the vegetation along the edges. Since rainbow trout are spring spawners they suffer more from these floods than the eastern brook trout which are fall spawners. The dams should assist greatly in providing safe spawning areas for them through the accumulation of sand and gravel bars.

Since these dams have been built in a series, though at varying distances apart, the sediment from the streams should be caught mainly in the first few, enabling the effectiveness of the lower ones to continue unimpaired.

Will the dams stay in during the heavy spring run-off? Will the spawning areas persist through high water? Will the big fish stay up instead of making the usual downstream migration in the fall? Will fishing be improved during the next year or two? Time will provide the answer. But in the meantime sportsmen and the Park Service alike await the developments with interest.

WATER DOGS EAT TROUT EGGS

By A. E. BORELL, Acting Junior Park Naturalist,
Yosemite National Park, California

Last spring Forest Ranger Otto Brown reported that on April 26 he found water dogs (Pacific Coast newts) in Laurel Lake which were eating trout eggs. He stated that three water dogs which he examined contained 39, 32 and 25 eggs respectively. To me this was new information on the food habits of the water dog. Therefore, on May 10, 1934, I made a trip to Laurel Lake to gather more data on the subject.

At the southern end of the Lake is a shallow outlet with a sandy bottom, which the rainbow trout use as a spawning ground. Drift logs and other debris had collected in the outlet affording shelter for the trout and also for the water dogs. At the mouth of the outlet the water flows slowly. On the day of my visit, there were three or four water dogs in sight most of the time. They walked slowly about the bottom thrusting their heads into the sand and litter, obviously foraging. Every few minutes the salamanders would come to the surface to breath, but returned at once to their foraging. When frightened, they swam to refuge beneath the logs.

Thirteen water dogs (*Triturus torosus*) were captured between 10 a.m. and 3 p.m. Eleven were placed in alcohol and two kept alive. At the Yosemite Museum the preserved ones were opened and the stomach contents examined. The following table gives the results of this examination, which would indicate that the food of water dogs in Laurel Lake at this time of the year consists mainly of caddis-fly larvae and trout eggs.

Specimens	*Trout eggs*	*Caddis-fly larvae*	*Small crustaceans*	*Minute snails*	*Small clams*	*Various water insects*
1	0	9	3	2	0	1
2	3	8	0	0	1	0
3	0	4	0	0	0	0
4	15	2	0	0	0	0
5	0	10	6	2	0	0
6	7	5	6	0	0	0
7	4	6	0	0	0	1
8	18	0	0	0	0	0
9	11	3	0	0	0	1
10	0	5	4	1	1	1
11	13	4	2	0	0	2
Total 11	71	56	21	5	2	6

Due to the mild winter rainbow trout spawned early that spring. At Laurel Lake on May 10, most of the trout were through spawning. This may account for the larger numbers of eggs found in salamanders on April 26 by Otto Brown.

It must be remembered that water dogs live in moist places most of the year, but in the spring they seek quiet, shallow water, where they breed and deposit their eggs. Unfortunately, the spawning season of

the water dog in this region corresponds more or less with spawning season of the rainbow trout. There are rarely, if ever, any salamanders in the water in the fall during the spawning season of the Loch Leven and eastern brook trout.

I kept two of the water dogs in captivity for some time and tried to feed them on trout eggs so as to determine the number of eggs which they might consume. They were placed in a large aquarium which had sand at one end and water at the other. The eggs were placed in the shallow water. Although the salamanders seemed to be content in the water before capture, they left the water when placed in the aquarium and spent most of their time on the sand and refused to eat any of the eggs.

Much more study will be necessary to determine the extent of destruction to trout eggs by water dogs. In this connection, there is one point which should be mentioned. Some caddis-fly larvae are herbivorous and others are carnivorous and possibly eat trout eggs. If caddis-fly larvae do eat trout eggs the water dogs may do as much good as harm, because of the numbers of caddis-fly larvae which they eat on the spawning beds.

EXPERIMENT TO DETERMINE THE FEASIBILITY OF THE USE OF TRAMMEL NETS IN MONTEREY BAY*

By J. B. PHILLIPS

INTRODUCTION

For a period of over one year, August, 1933, to December, 1934, an experiment was carried on by the Bureau of Commercial Fisheries of the California Division of Fish and Game to determine the feasibility of the use of trammel nets in Monterey Bay. Permission for the experiment was granted by the Fish and Game Commissioners and the executive officer of the Division of Fish and Game. This permission allowed one fisherman, with his boat plus necessary assistance, to operate under supervision of the Bureau of Commercial Fisheries.

DESCRIPTION OF TRAMMEL NETS

A trammel net is an entangling net, having three walls of webbing between a common cork line and lead line. The middle web or net is of finer mesh, loosely hung, and the guard mesh on either side is of large mesh, hung taut. The mesh of the outside guard nets is usually about three times as large as the mesh of the inner net.

Although the three-walled trammel net is most widely used in California, a two-walled trammel net has been used occasionally. This latter type has but one wall of coarse webbing on only one side of the finer mesh and is therefore effective from but one direction. When gill nets hang slack by short lengths of twine between the cork line and lead line on either side of the fine mesh webbing, they are classified as trammel nets in California.

Trammel nets are made up into sections or pieces, usually 20 to 40 fathoms long and 2 to 4 fathoms deep. A number of these sections are tied together, cork line to cork line and lead line to lead line, to form a string. This arrangement allows sections damaged by porpoises or sharks to be readily removed for repair and facilitates the tanning and stowing of nets. The string of nets is anchored in a straight line and the nets hang perpendicularly in the water with the lead lines touching the bottom. Trammel nets are used primarily for the capture of flatfish.

A trammel net operates in the following manner: A fish of a size that can pass through the outer guard webbing and yet too large to pass through the inner finer mesh, pushes the inner finer mesh ahead of it through one of the large meshes of the guard webbing on the other side, thus forming a pocket in which it is held.

* Contribution No. 148 from the California State Fisheries Laboratory, January, 1935.

TRAMMEL NET LEGISLATION IN CALIFORNIA

The following legislation relating to trammel nets in California waters has been enacted:

1911. Law prohibited use of trammel net, two-mesh, or three-mesh net in the State for catching of fish, shrimp and shellfish.

1913. Amendment provided two- or three-mesh trammel nets with stretched mesh of 7½ inches or larger could be used in Monterey Bay, outside of one mile from shore, outside of existing fish and animal reservations, and outside an imaginary line from the outer end of Moss Landing wharf to Pt. Santa Cruz; and provided further that such trammel nets should not remain "in a fixed or set condition for a period of time of more than six hours . . . without taking up . . . and removing any fish that may have been taken therein."

1915. Amendment eliminated trammel nets in the Monterey Bay districts, and provided for use of trammel nets of not less than 8 inches, stretched mesh, in Districts 10, 18 and 19 for taking fish only. It was required that in these districts, the nets must be raised at least every six hours to remove the fish. In District 18, trammel nets should not be used between the seaward boundary of any kelp bed and high-water mark, or within 100 yards in any direction from any kelp bed. Trammel nets also permitted in Districts 12B and 12C, but minimum stretched mesh should not be less than 5½ inches, except between May 16 and June 15, when minimum stretched mesh could not be less than 7½ inches.

REASONS FOR PRESENT EXPERIMENT

The main reason for the elimination of trammel nets from the Monterey Bay districts in 1915 was because of the destructiveness to netted fish by hagfish or "eels," which are especially numerous on the muddier bottom portions of Monterey Bay. The present experiment was undertaken to determine the nature and extent of this destructiveness and to determine whether or not this type of net should be permitted to operate. Hook and line fishing for flatfish in Monterey Bay is uncertain, and trammel nets are the only type of gear that can be depended upon for their capture, aside from drag nets. When damage by hagfish can be reduced to a minimum, the trammel net is a more desirable gear for the capture of flatfish in bays than is the drag net.

DESCRIPTION OF HAGFISH

The hagfish and its relative, the lamprey, are not true fishes and therefore not closely related to the true eel, the moray eel or the blenny eel. Hagfish and lampreys belong to the class Cyclostomata. These animals are without functional jaws and lateral appendages and have only one olfactory pit. Hagfish are entirely marine inhabitants whereas lampreys are anadramous.

There are two species of hagfish found in California waters: *Polistotrema stoutii* and *P. deani*. The former is the one that is most common in Monterey Bay. It is found in 10 to 40 fathoms of water. The color of *P. stoutii* is brownish red and 10 to 14 pairs of gill openings are present along the sides. Specimens from Monterey Bay reach a length of about 20 inches and 1¼ inches in diameter. *P. deani* is a smaller form that *P. stoutii*. It is found in deeper water, 80 to 500

fathoms, from Alaska to Santa Barbara. The color of *P. deani* is blackish, and 10 to 12 pairs of gill openings are present along the sides.

Hagfish do not have a sucker around the mouth as do lampreys. Instead, there are four tentacles on either side of the mouth. Also, inside the mouth is a single median sharp-pointed tooth. When hagfish are endangered they emit, through pores along the sides of the body, clouds of mucilaginous slime that makes them not only unpalatable but hard to grasp. The reason that hagfish are so destructive is that the food they take in passes largely undigested through the alimentary tract, thus necessitating the intake of large bulk. A hagfish fastens itself to a fish and enters under the gill covers or through the mouth, mainly, when the fish is too weak or not in a position to resist. The muscular hagfish will rasp out and ingest all the flesh and vascular organs of a fish that is large enough for it to enter, leaving but a shell of skin.

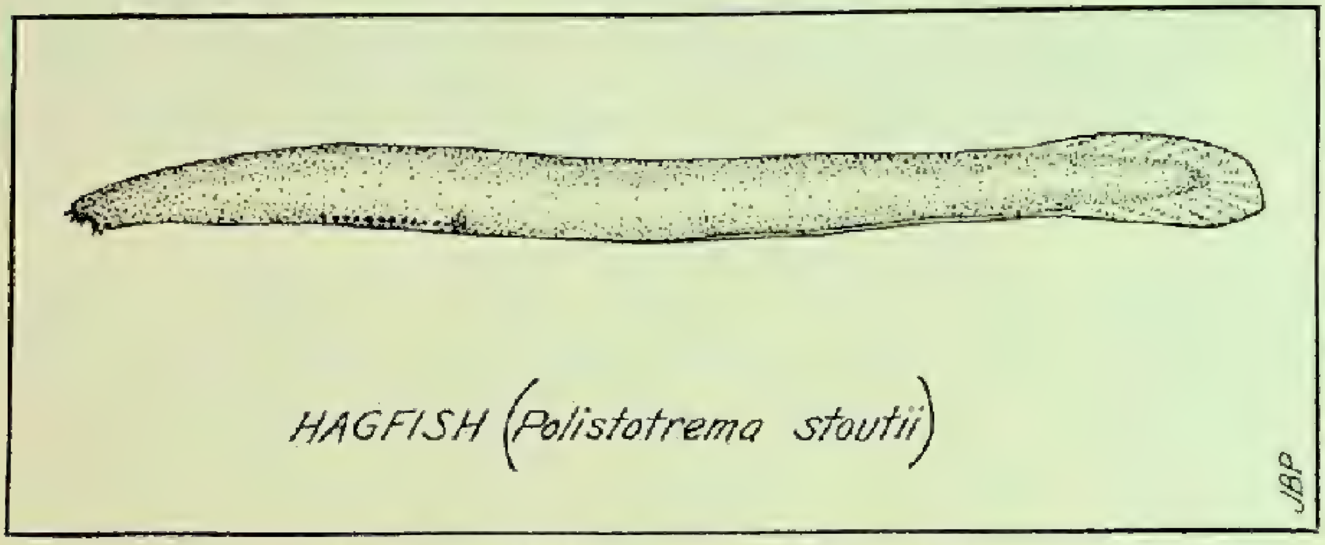


FIG. 45. Hagfish. (*Polistrotrema stoutii*).

EXPERIMENTAL FISHING

FISHING ARRANGEMENT

In order to conduct the experiment with a minimum of expense to the Bureau of Commercial Fisheries, it was decided to ask some experienced net fisherman to volunteer to make up and operate the trammel nets at his own expense, in return for which he would be entitled to market the catch.

Through the cooperation of George Christo, B. Bregante, a veteran net fisherman and member of the Santa Cruz Fisheries, Inc. (a cooperative association that includes about 70 per cent of the regular fishermen at Santa Cruz), agreed to do this work under the terms given above. We were fortunate in obtaining the services of Mr. Bregante as we found him reliable, experienced and agreeable.

DESCRIPTION OF EXPERIMENTAL GEAR

Eleven sections of trammel net, patterned after the three-mesh trammel nets used in southern California for California halibut, were made by Bregante at a cost of $31 a section. Each section or "piece" was 30 to 32 fathoms long and 2½ to 3 fathoms deep. The inner net was of 9-thread, medium cotton twine, and the meshes measured 8

inches, stretched, when new. The outer guard nets were of 12-thread, medium cotton twine, and the meshes measured 18 to 24 inches, stretched, when new. After the nets were used for a short period and tanned several times, the meshes had shrunk $\frac{1}{4}$ to $\frac{1}{2}$ inch. The inner net was 28 meshes deep and was hung 6 meshes slack in the depth of the net, and $1\frac{1}{2}$ meshes slack lengthwise of the net. The outer guard nets were 8 meshes deep and were hung without slack either in the depth or the length of the net. The corks along the cork line were about 3 inches in diameter and spaced about one to the foot. Along the lead line, 1- to 2-ounce leads were spaced about 6 inches apart. Cork line and lead line ropes were of $\frac{1}{4}$-inch diameter, and anchor ropes were $\frac{1}{2}$ to $\frac{5}{8}$ inch diameter.

A 15-pound dory anchor was used to anchor the string of nets at either end. A 3-gallon barrel was used as a float at either end of the string of nets. The markers were bamboo poles about 10 feet long and about an inch in diameter at the basal end, where these markers were weighted with a few pounds of iron. A number of corks were closely attached a few feet up from the basal end. This arrangement of weights and corks caused the marker to float upright in the water. For identification, at the tip of one marker was attached a light colored piece of cloth and on the other marker was attached a dark colored piece of cloth.

OPERATING TRAMMEL NETS

Two fishermen on a boat[*] ordinarily operate a string of gill or trammel nets. The nets are piled on the port side of the after deck, or if room is lacking the balance is piled on the opposite side of the boat. When the nets are piled, they are simply coiled back and forth with lead line and cork line together and the webbing bunched opposite. Setting or raising a string of nets is a continuous operation as the marker is attached to the float, the float to the anchor and the anchor to one end of the nets. With the boat traveling at slow speed, the float and marker are thrown overboard and then the anchor, which is dragged a short distance to cause the flukes to dig in, after which the nets are paid out over the side of the stern. As the nets are paid out, the cork line is kept well above the lead line to prevent entangling as much as possible. The string is laid out in a straight line paralleling shore and is not baited in any manner. Due to the weight of leads on the lead line, the nets sink until the lead line touches the bottom. The corks on the cork line keep the wall of webbing extended upwards. When the last of the string is in the water, the anchor on that end is cast overboard and made to bite in, after which the remaining float and marker are tossed over. The only visible evidence of the submerged string of nets is the float and marker at each end.

Under ordinary fishing conditions, the fishermen set out early enough each morning to start raising the nets at daybreak. One of the fisherman sets a portable box compass on the deck in front of him as he stands in the stern pit and guides the boat by means of the short arm or tiller on the rudder. The speed of the engine is controlled from the stern pit by means of a small pole hooked onto the throttle.

[*] Boats used for gill or trammel net fishing in Monterey Bay usually vary from 25 to 35 feet long and $7\frac{1}{2}$ to $8\frac{1}{2}$ feet wide, and are powered with 6- to 12-horsepower gasoline engines.

On foggy mornings, when no landmarks are visible, the fisherman waits until daybreak and then guides his boat to the vicinity of the set net by compass and watch. As the compass course may not be too accurate and the float and marker are a small target, the fisherman must some-

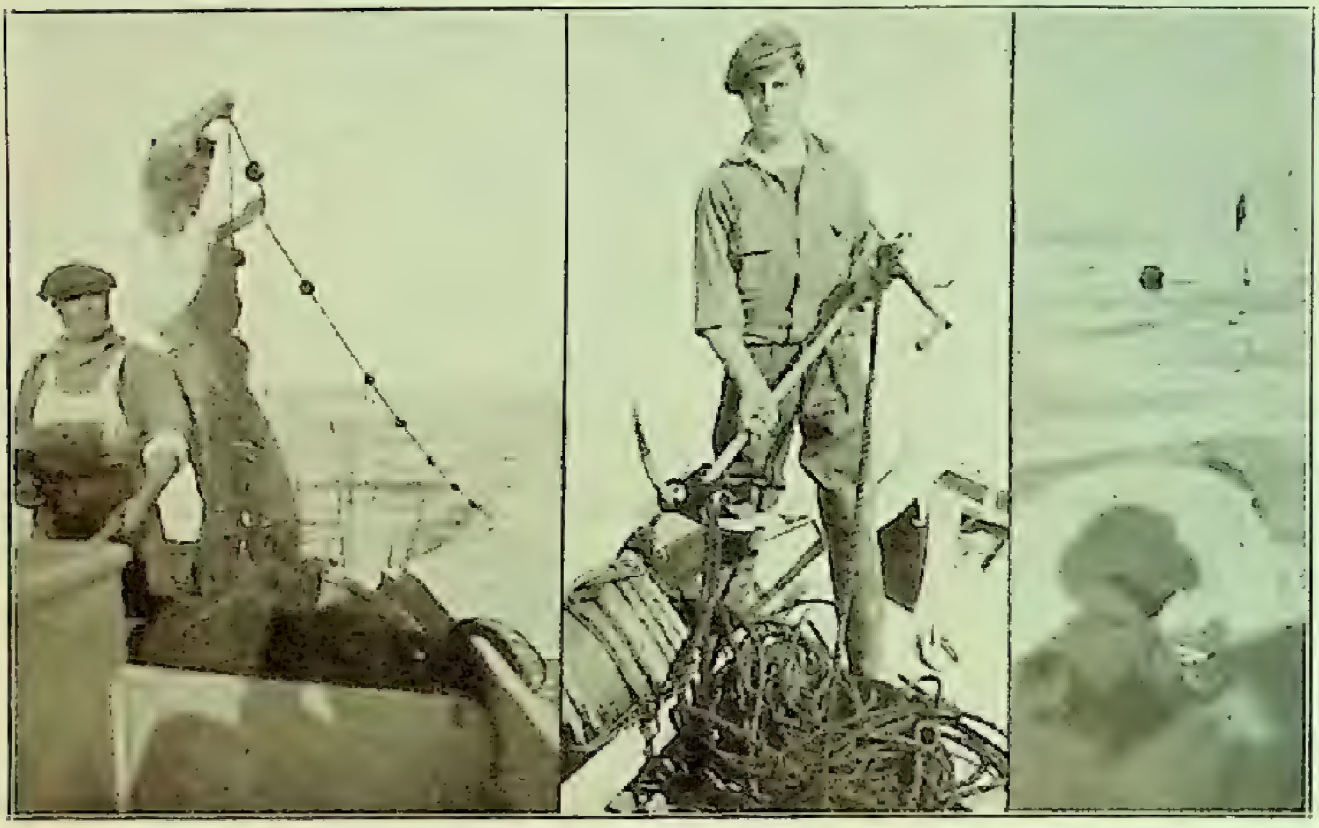


FIG. 46. Left view shows a trammel net being set. Center view shows one of the anchors that is attached at either end of the string of nets. Right view, the string of nets is submerged, and all that is visible at either end are the buoy and marker. Photographs by J. B. Phillips, March, 1934.

times do some scouting after he has run his course for the required time. This is done by circling in ever widening circles until the marker and float are detected.

If there is a surface drift of water or a wind, the nets are pulled against the "run" of the sea so that the boat can not drift over the net. The marker and float are lifted on board and then the anchor brought aboard. When the end of the string comes up, the engine, which has been kept idling, is shut off. The nets are then pulled in over the demountable roller on one side of the stern. One man stands in the stern pit and pulls net, while the other man removes the catch from the nets and stacks them for resetting.

RESULTS

During a period of 16 months, August, 1933 to December, 1934, a total of 173 sets were made with the experimental trammel nets. Under ordinary commercial fishing conditions, it is probable that twice as many sets could have been made. Most of the sets covered a period of approximately 24 hours; a few sets were made during daylight only and some at night only. These sets covered periods of 8 to 12 hours. All of the sets were made in the northern half of Monterey Bay where most of the commercial fishing for flatfish is done. Fishing was carried

on in from 3 to 20 fathoms of water along a stretch of about 8 miles between a point south of the Santa Cruz wharf and southeasterly to a point west of Red Sand Hill.

POUNDAGE AND VALUE TO FISHERMEN OF MARKETABLE FISH

During the period, August, 1933 to December, 1934, a total of 24,500 pounds of marketable fish valued at $1297.00 was taken.

In table 1 and figure 47 are given the total poundage and the percentage of various species of marketable fish taken in the trammel nets during the 173 sets made during the 16 months.

TABLE 1

Total Poundage and Percentage of Total of Various Species of Marketable Fish Taken in Trammel Nets During 173 Sets Over Period of 16 Months

Species	*Lbs.*	*Per cent of total lbs.*
California Halibut	14,800	60½
Starry Flounder	4,550	18½
Turbot	1,140	4½
Round-nosed Sole	985	4
Pacific Cultus	775	3
Market Crab	700	3
Pointed-nosed Sole	530	2
Fringe Sole	380	1½
Cabezone	300	1½
White Sea-bass	125	½
Rockfish	115	½
Salmon	75	½
Miscellaneous	25	0
Totals	24,500	100

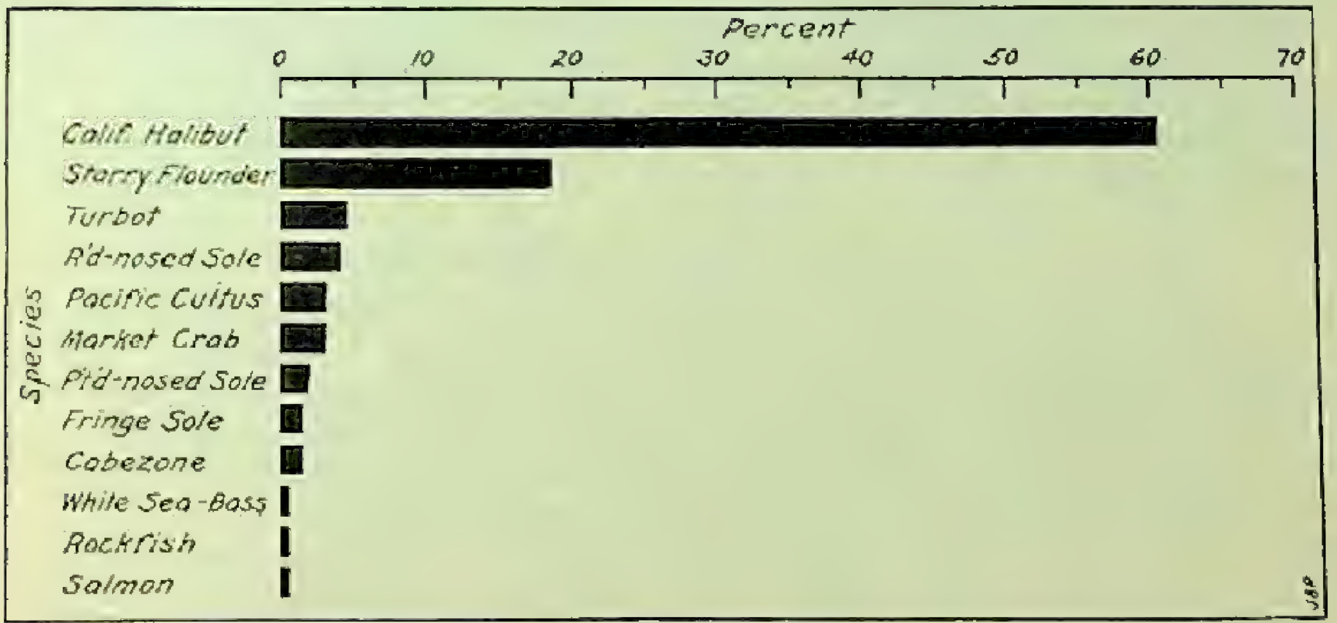


FIG. 47. Percentage of total poundage by species of marketable fish taken in experimental trammel nets.

In table 2 and figure 48 are given the total poundage and percentage, together with the total value and percentage of the principal marketable fishes taken in the trammel nets. This table is simply a grouping of the various species of the fish tabulated in table 1.

Table 2

Total Poundage and Percentage of Total, and Total Value and Percentage of the Main Groups of Fishes Taken in Experimental Trammel Nets During 173 Sets Over Period of 16 Months

	Lbs.	*Per cent of total lbs.*	*Value*	*Per cent of total value*
California Halibut	14,800	60½	$996 00	77
Other Flatfish	7,585	31	219 00	17
Other Market Fish	1,415	5½	55 00	4
Market Crab	700	3	27 00	2
Totals	24,500	100	$1,297 00	100

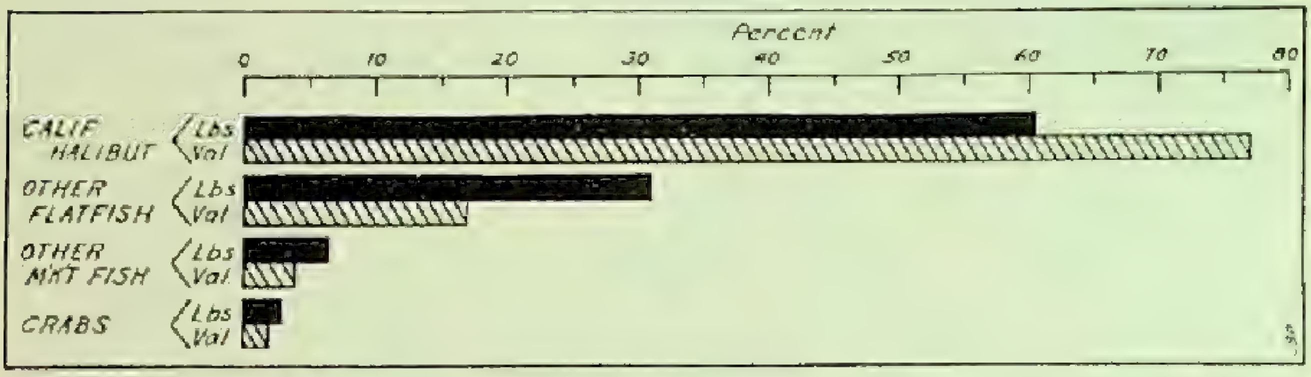


FIG. 48. Percentage of poundage and value of main varieties of marketable fishes taken in experimental trammel nets.

The above tabulations of relative proportions of various species of fish taken in the experimental trammel nets are of course not a criterion for trammel net catches throughout Monterey Bay, as the sets were not made throughout the entire bay. However, the area fished with the experimental nets represents choice grounds for this type of fishing (except for the area between the Red Sand Hill and Moss Landing, where the bulk of the commercial market crab fishing is carried on) and is perhaps a fair representation of what might be expected in the southern portion of Monterey Bay in regard to the main groups of fishes taken.

AMOUNT OF DESTRUCTION BY HAGFISH

The ensuing evidence is based upon ordinary commercial fishing methods with sets of approximately 24 hours' duration. During shorter periods of 8 to 12 hours per set, such as night time only and day time only, destruction due to hagfish was somewhat lower. However, the shorter periods have been found impractical both from the standpoint of the fisherman and of law enforcement.

The experimental trammel nets were set in depths ranging from 3 to 20 fathoms. The destruction by hagfish to a depth of 10 fathoms may be considered negligible. To a depth of 7 fathoms, no destruction due to hagfish was noted. From 7 to 10 fathoms, damage equalling about 10 per cent of the total poundage taken at those depths occurred. From 10 to 15 fathoms, the damage was about 20 per cent of the total amount. Whereas from 15 to 20 fathoms, the damage was about 53 per cent of the total amount taken at these depths. These percentages are plotted graphically in figure 49.

The above data show that the destruction by hagfish increases with the depth fished and this increase is very great at depths of 15 to 20 fathoms.

The increase in destruction by hagfish with increasing depth seems to conform in the area studied with the nature of the bottom deposits of Monterey Bay. In shallow water, the sandy bottom does not harbor hagfish, but with increasing depth the numbers of hagfish increase as does the amount of silt and clay on the bottom. At 20 to 25 fathoms, soft mud is encountered as well as larger numbers of hagfish.

Set net fishermen have an idea that hagfish sense the more valuable fish in the net, as they are the ones mainly destroyed. However, it happens that the more valuable food fish are the ones that are the larger and more readily entered. Although the starry flounder and turbot are also desirable market fish, the damage to them is negligible because these species have small gill openings and small mouths. Any flatfish of about a pound or less in weight is not thick enough for an ordinary hagfish to enter. Hagfish not only enter valuable market varieties but also less desirable species, such as hake, sharks and porpoises.

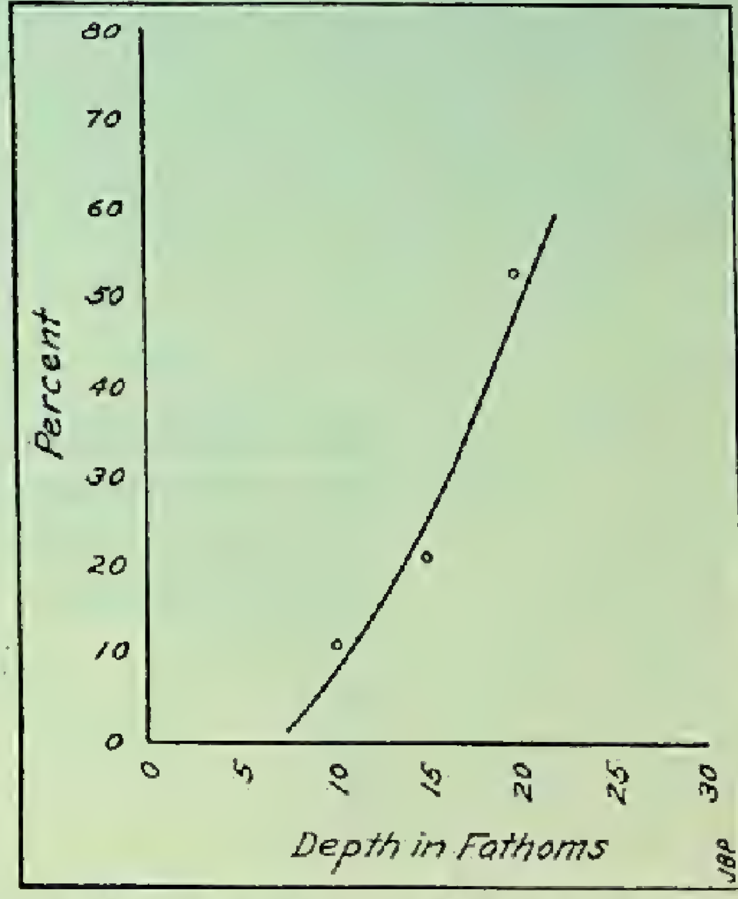


FIG. 49. Percentage of marketable fish (total poundage) destroyed by hagfish in experimental trammel nets at depths to 20 fathoms.

The percentages of the individual poundage of various species of marketable fish destroyed by hagfish in the experimental trammel nets in depth of 10 to 20 fathoms are as follows: (See also Fig. 50.)

Species	*Per cent of individual poundage destroyed*
Pacific Cultus	41
California Halibut	28
Salmon	27
Cabezone	19
Rockfish	11
Round-nosed Sole	5
Pointed-nosed Sole	4
Starry Flounder	2
Turbot	2

About one-tenth of the 173 sets were for shorter periods than the regular day and night sets of approximately 24 hours. These shorter sets were made to determine the practicability of day or night periods

of fishing. If practical, trammel nets probably would be allowed to operate only during one phase of the day to insure the raising of the nets at shorter intervals and thereby to curtail the destructive activities of hagfish. The daytime sets were for periods of 7 to 9 hours, whereas the night sets were for periods of 14 to 15 hours.

Although the daylight sets were a few hours shorter in duration than the sets made at night, the average of the catch of daylight sets was over twice that of night sets. When the nets were set in deeper water, the destruction by hagfish was negligible during the daytime and was about one-half as great as the 24-hour sets during the night. In one or two of the daylight sets, it was found that hagfish had just started to work on one or two fishes when the nets were raised.

These experiments indicated that when trammel nets are set in deeper water for a period of less than 8 hours, the destruction by hagfish will be negligible. After that period, the destruction may become increasingly greater until the amount of destruction, after a period of

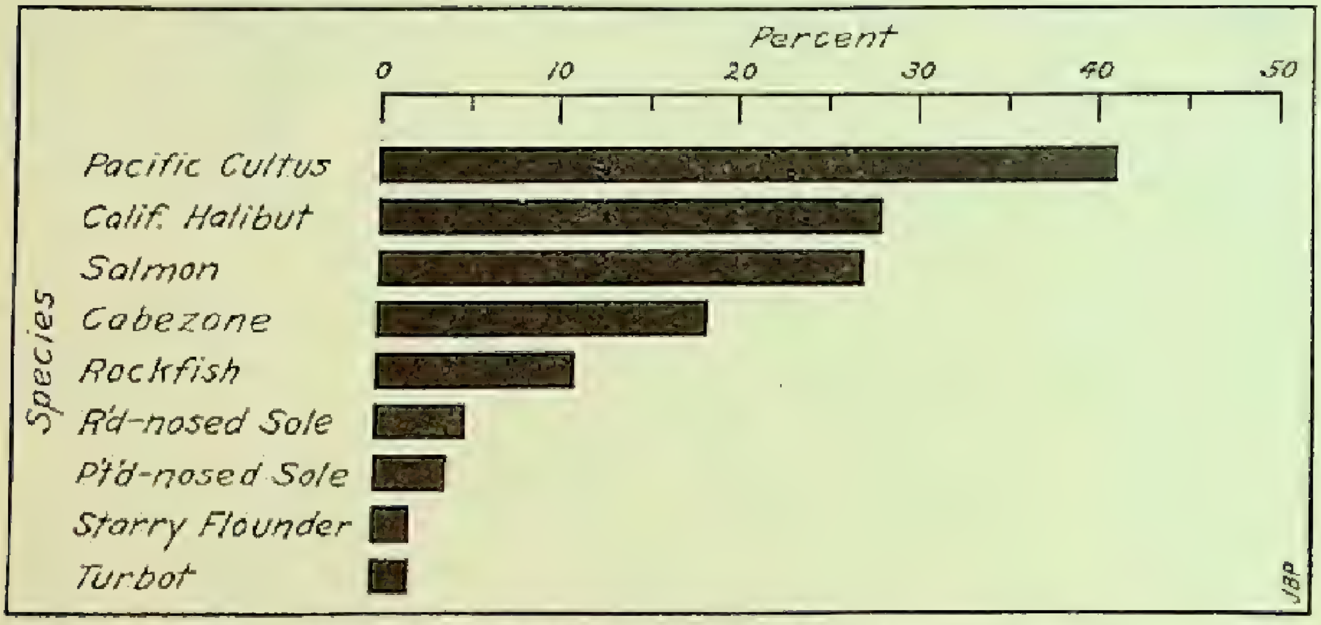


FIG. 50. Percentage of the poundage of each marketable species destroyed by hagfish in experimental trammel nets at depths of 10 to 20 fathoms.

24 hours in some portions of Monterey Bay, may amount to over 50 per cent of the catch of certain valuable market fishes. It is evident that these fishes are able to resist the advances of hagfish while still fresh in the nets. The longer these fishes stay in the net, the weaker and less resistant they become. In this work, it has been found that the main entrances of hagfish to fish caught in trammel nets are under gill covers or through the mouth, particularly in thick-skinned fish such as flatfish.

RECOMMENDATIONS

It is recommended that from April 1 until October 1, trammel nets (also known as three-mesh and two-mesh nets) be permitted in the waters of Monterey Bay except Districts 15 and 16 therein. The smallest mesh should be not less than $7\frac{1}{2}$ inches, stretched. From October 1 until April 1, no trammel nets should be permitted in the waters of Monterey Bay nor should they be allowed on any boat within Monterey Bay during this period.

One of the objects of the experimental work was to determine the success of shorter periods of fishing, such as daylight and night fishing. Perhaps, the best method of regulating trammel nets is to have the nets raised at short intervals, *i.e.*, 6 to 8 hours. Under this regulation, trammel nets might be permitted all the year around, as the damage would not be great when the nets are set in deeper water in hagfish infested areas. However, such an arrangement would tax the enforcement bureau beyond its capacity and most likely render such restrictions valueless.

Therefore no requirement as to the frequency of lifting nets is proposed, but it is recommended that trammel nets be permitted in Monterey Bay only from April 1 to October 1. During this period the season of severe storms is over and the trammel nets would, for the most part, be set in shallow water of 10 fathoms or less, where damage from hagfish is negligible. It has been shown in this work that damage to fish captured in trammel nets increases greatly from 10 to 20 fathoms in some portions of the Bay. Net fishermen are under the impression that hagfish (eels) work most intensively in the winter time when storms roil the water. However, it is during the winter stormy period that the nets are set in deeper water, 12 to 25 fathoms, because of the roughness in shallow waters. Fishermen would rather set their nets in shallow water of 10 fathoms or less all year around, but cannot do so during the stormy winter months because the nets are apt to be damaged or cast upon the shore. In the late spring, summer and early fall months, the fishermen are able to set their nets in water as shallow as 3 fathoms. In the experimental work, the fishermen in most cases were allowed to set their nets where desired. During the months between April 1 and October 1, the nets were set for the most part in water from 3 to 10 fathoms. The fishermen prefer to set their nets in shallow water when possible because the labor of hauling is lessened and it has been found that the desirable varieties of fish are in shallow water at this time.

A minimum mesh of 7½ inches is proposed in order to minimize the capture of flatfish of less than one pound and of other smaller fishes.

APPENDIX

Earnings of Fishermen

Gross value of catch to two fishermen for 173 sets from August, 1933, to December, 1934		$1,297 00
Gross value of catch to two fishermen for one set		$7 50
Approximate net depreciation for each 24-hour set (nets must be renewed after about 330 sets)	$1 00	
Approximate amount spent for fuel on basis of one set	50	
Approximate expense (total) of making one set, not including depreciation of boat		$1 50
Net return to two fishermen per 24-hour set (one day)		$6 00
Net return to one fisherman per 24-hour set (one day)		$3 00

Judging from the experimental work, if trammel nets were permitted in Monterey Bay during the period April 1 to October 1, the earnings of a successful fisherman might approximate $75.00 a month on the basis that 25 sets of 24-hour duration are made each month. This allows no return on boat investment or depreciation.

Marketable Species Caught

Common names	*Scientific names*
California Halibut	*Paralichthys californicus*
Round-nosed Sole	*Eopsetta jordani*
Pointed-nosed Sole	*Parophrys vetulus*
Fringe Sole	*Psettichthys melanostictus*
Starry Flounder	*Platichthys stellatus*
Sharp-ridged Turbot	*Pleuronichthys verticalis*
California Turbot	*Pleuronichthys decurrens*
Diamond Turbot	*Hypsopsetta guttulata*
Northern Halibut	*Hippoglossus hippoglossus*
Pacific Cultus	*Ophiodon elongatus*
Cabezone	*Scorpaenichthys marmoratus*
Green-spotted Rockfish	*Sebastodes chlorostictus*
King Salmon	*Oncorhynchus tschawytscha*
Market Crab	*Cancer magister*

Roughage Taken

Aside from the marketable varieties of fish, the following roughage was taken in the nets, in the order of their abundance:

Common names	*Scientific names*
Big Skate	*Raja binoculata*
California Skate	*Raja inornata*
Hake	*Merluccius productus*
Grayfish	*Squalus suckleyi*
Soupfin Shark	*Galeorhinus zyopterus*
Guitar Fish	*Rhinobatus sp.*
Bat Sting Ray	*Aetobatus californicus*
Shovel-nosed Shark	*Hexanchus griseus*
Harbor Porpoise	*Phocaena phocaena*
Smooth-hound Shark	*Rhinotriacis henlei*
Leopard Shark	*Triakis semifasciata*
Thresher Shark	*Alopias vulpes*
Angel Shark	*Squatina californica*
Basking Shark	*Cetorhinus maximus*

Also at times large numbers of various species of starfish and rock crabs were taken. Small numbers of spider crabs and jellyfish were caught occasionally.

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NEWLY APPOINTED COMMISSIONERS

Dr. E. C. Moore, widely known sportsman of Los Angeles, is the new President of the Fish and Game Commission, and he has already made it apparent that the personnel of the Division is to devote its entire energies to its real purposes, the conservation of fish and game and impartial enforcement of laws.

DR. E. C. MOORE,
President Fish and Game Commission.

In speaking before the annual meeting of fish and game wardens in Sacramento on March 2, he stated:

"I want to say this to you. The present Fish and Game Commission is going to be devoid of politics in any way whatsoever. We are all going to stand on our own merits, not only the members of the Fish and Game Commission, but you men also. The Fish and Game Commission is going to work as a unit in establishing policies.

"We want you to be courteous to all of the citizens of the State and to enforce vigorously all of the laws on the statute books."

Dr. Moore was echoed in his policies by Elmer Houchin of Bakersfield, the other new member of the Commission, and by I. Zellerbach of San Francisco, who has given many years of constructive and faithful service as a Commissioner.

When Dr. Moore first was approached by his friends and asked if he would accept the appointment, if tendered, he was dubious about doing so, saying that he had no technical qualifications in this line of work, but when his long experience as a sportsman was recalled and his abiding interest in real conservation cited, he stated that he would consider such an offer. "I want my children and grandchildren to

enjoy the same wonderful privileges that I have enjoyed in this State,'' he said. ''In order to do so we must conserve our natural resources and if I can help to do this I would consider it an honor to accept the post.''

Dr. Moore has thousands of friends in all parts of California and is outstanding as an organizer and in his own profession. He has a counterpart as regards real sportsmanship and desire for law enforcement and conservation in Elmer Houchin, the other new Commission member. His home is in Bakersfield, but there are very few places in the State where he has not carried his rod and gun. He has been a leader in busines activities for many years and is widely known for his judgment and ability to solve knotty problems. He brings a wealth of courage and desire to serve to the position and pledges that whatever

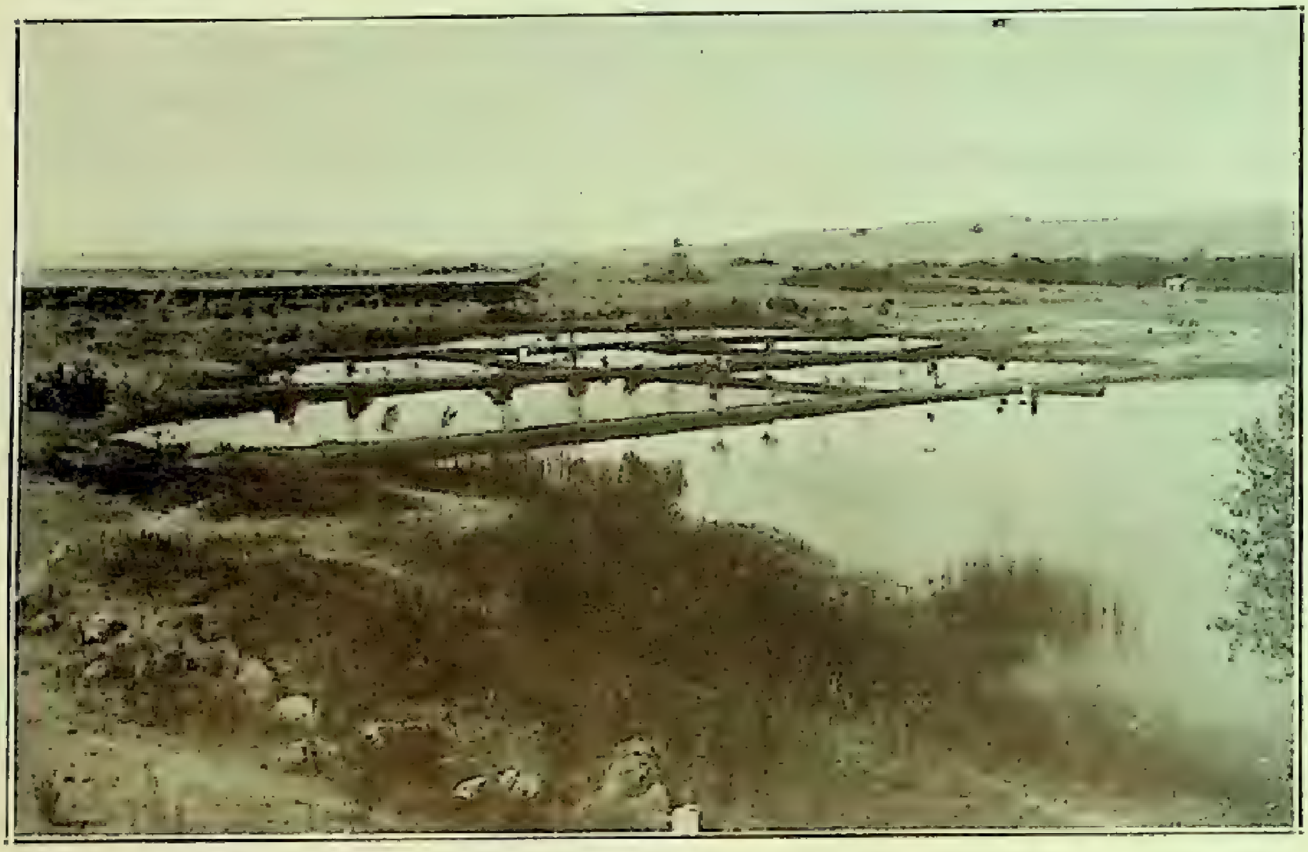

FIG. 51. Bass Ponds at Friant, near Fresno. Photo by J. O. Snyder, 1934.

time is necessary to bring about the best interests of the Division of Fish and Game will be given to the job.

When it is considered that these new members will have the mature advise and cooperation of I. Zellerbach, prospects are bright for a most successful administration of the Division's affairs.—*E. D. Blake.*

SMALL MOUTH BASS PROPAGATION

Notable progress was made in the second year of the propagation of small-mouth black bass at the Friant Ponds. The foreman in charge, Merrill Brown, has successfully met the trying conditions which were bound to appear in a region entirely foreign to the native habitat of the species. Methods somewhat different from those in general practice were developed, and it is believed that the procedure has now passed the preliminary experimental stage. However, no very extended expansion of the activity will be indulged in until something definite is

learned in relation to the final success of the several introductions of fish produced at the ponds. The plantings have all been made in places where some measure of the possible returns may be made. If and when these expected returns justify more extended work in this direction, further propagation is planned in cooperation with fish rescue which is now in the hands of the bass hatchery foreman. Coordinated work in the two fields will greatly reduce the expense of propagation, and no doubt add to the material results.

Fish rescue consists of removing stranded fish to live waters and in holding certain desired species for transportation and planting in favorable places where new introductions are desired. At present there is no adequate provision for the latter activity, and the acquisition of a suitable tract of land, ample in acreage for future expansion where holding and propagating ponds may be installed, and where headquarters may be established, is desired.

The first year of operation at Friant cost \$4,138.62 and produced 6876 fish by actual count. These measured $2\frac{1}{2}$ to 3 inches. The second year cost \$4,227.35 and produced 39,004 fish. The costs of transportation and planting, and some improvements, were included in both cases. It is intended that careful accounting will be rendered so that the cost and the actual production will be available from time to time.

Through the courtesy of T. H. Langlois, Chief, Bureau of Fish Propagation, State of Ohio, several hundred small examples of the recently described southern, or Kentucky bass, were brought to the ponds at Friant where the survivors will be held for brood stock.—*J. O. S.*

HATCHERY FEEDING EXPERIMENTS

Comment is in order relating to the article on feeding experiments in this issue of CALIFORNIA FISH AND GAME. These experiments constitute part of a program initiated by the Bureau of Fish Culture to combat disease and the resultant losses in our hatcheries. The entire procedure is founded on the generally accepted belief that our ability to control disease is proportional to our knowledge of it. The first duty of the man in direct charge of the work was to determine the various diseases present in our hatcheries and streams. That matter is now well in hand, and it is sufficient to say that nearly all known diseases are present, together with some others the cause of which is not sufficiently clear. Some diseases become epidemic at certain times in particular places. When these are determined, the problem becomes one of prevention. In fact, the major procedure is one of prevention rather than "doctoring," just the reverse of what is believed in some quarters.

As stated in the paper, the experimental work was performed under ordinary hatchery conditions and with the normal crowding of young fish. It was done in the midst of our largest plant where conditions at the present time are none too favorable. Other hatcheries located near by served in a measure as controls. The results are well worth careful consideration. It is apparent that vastly better results may be had in many of our hatcheries with the same financial outlay. The present experiment is being extended, broadened and elaborated,

and if it meets with something of the same success, it alone will serve to justify the entire disease program.—*J. O. S.*

FROM THE FOREST HOME HATCHERY

D. A. Clanton furnishes some interesting notes from the Forest Home Hatchery and the San Bernardino region.

In 1933 we planted 540,940 trout measuring 5 to 9 inches long, and weighing 43,419 pounds; 715,000 fingerlings measuring 1½ to 2 inches, weighing 1859 pounds; and 11,000 silver salmon 5½ inches long, weighing 515 pounds, a total of 1,226,940 fish weighing 45,793 pounds. These fish ate a total of 164,458 pounds of food, showing that it took about 3.6 pounds of food to produce 1 pound of fish. Although 36,000 pounds of canned fish were secured for the expense of hauling, it cost about 21.5 cents for the food to produce one pound of fish.

Some Loch Leven trout held under different conditions were placed under observation. They were all started at the same time, some in troughs, some in large wooden tanks, and others in a pond or raceway. In no case were they overcrowded, and water conditions were similar regarding source and temperature. On July 3 the trough fish measured 30 to the ounce, the tank fish 25 to the ounce, and the pond fish 20 to the ounce.

We find that the rapid growing pond fish must be carefully graded at least every six weeks to prevent cannibalism. Careful feeding tends to produce fish without great variation in size. When introducing very small fish into the ponds—those just beginning to feed well—we hold about a twenty inch depth of water. At first we feed five times a day, taking plenty of time and keeping the fish well spread. Each little fish is given a chance and the food is nearly all eaten.

When the fish are kept properly graded and not crowded, the losses are relatively small. In case of overcrowding, disease soon follows—gill-disease, gyrodactylus, octomitus and all the rest appear. Clean ponds, proper feeding, and plenty of space to avoid overcrowding contribute largely to the health and growth of fish.

Planting aged fish is a problem largely because of difficulty of access to the streams. Tests were made to determine if fish would spread after placing large numbers in certain pools. It was found that they would not. One particular test was a planting of 3000 large eastern brook trout in Deep Creek on November 15. They were observed during the winter and as late as March 12 they had not spread over a half mile. Although they were 6 inches long they became very thin. Rainbow and Loch Leven spread better, and the latter are more wary and apt to keep out of sight.

The streams of southern California are subject to heavy fishing. One May first disclosed 150 anglers on less than a half-mile of the North Fork of San Gabriel. Another location showed 150 anglers on a six-acre pond.

Bear Lake conditions are improving through careful planting. For some time large fish, six inches or so, have been distributed from a boat at a considerable distance from shore. As a measure of the increase it may be noted that in 1932 20,000 eggs were taken for purposes of propagation, while in 1934, 3,000,000 were secured with the same effort.—*J. O. S.*

THE IMPERIAL VALLEY GAME REFUGE

The experience that we have had with the general public in the Imperial Valley since we purchased the Imperial Refuge has been most pleasing. When we first took over the refuge there were many who honestly doubted the wisdom of having a refuge located in the valley and whether we would be good neighbors. There was complaint on account of our taking some 2000 acres off the assessment roll and a fear of whether the property could be used for recreational purposes.

Time has proven the error of their fears. When there is a heavy concentration of waterfowl, enthusiastic visitors get a great deal of pleasure watching the birds. After the birds are gone, scarcely a week goes by but there are not one or more picnic parties. During the water shortage of last summer the refuge proved a life saver of stock for miles around. Thousands of gallons of water were pumped from our lakes and hauled in tank cars and wagons to thirsty herds.

The local CWA and SERA authorities have approved projects calling for the expenditure of nearly $15,000 in construction of levees and ditches and improving picnic grounds. The County Board of Supervisors has helped us in many ways. We are now regarded as good neighbors in the valley.—*J. S. Hunter.*

COMMERCIAL FISHERY NOTES

CUTLASS FISH (*Trichiurus lepturus*) IN THE SAN PEDRO FISHERY

The cutlass fish, found in warm seas throughout the entire world, has been recorded from California waters only occasionally. But in the latter part of November, 1934, a small Italian round-haul boat brought in several pounds of these fish daily for a period of ten days. Between November 21 and November 30, 170 pounds were delivered. From January 18 to 23, two or three specimens were caught each day. On February 21, another round-haul boat caught two of these fish. These boats fish in the waters adjacent to San Pedro and bring their catches to the wholesale markets each morning. The cutlass fish were taken, therefore, only a short distance from Los Angeles Harbor. The Japanese dealers readily purchased the fish at 8 and 9 cents a pound.

The cutlass fish is related to the scabbard fish but differs from the latter in the complete absence of a tail fin. This long, slender, band-shaped fish is of a uniform silvery color. The dorsal fin extends the entire length of the body and meets the inconspicuous anal at the posterior tip of the body. The pectoral fins are short and the ventral fins lacking. The mouth is large and contains many prominent canine-like teeth.

The fishermen claim that these fish are more easily found during the full moon, and all catches recorded in the past four months occurred during the week of the full moon. The observations are not sufficient, however, to verify completely the validity of the fishermen's claims. —*Frances N. Clark, California State Fisheries Laboratory, February, 1935.*

THE 1934 PISMO CLAM CENSUS

The annual Pismo Clam census was made at Pismo Beach by the California State Fisheries Laboratory on November 19 to 21, 1934.

Clams were found to be relatively abundant on the beach, due to the good sets in 1929, 1930 and 1931. The 1934 set was practically a failure, representing the poorest set since 1923. Because the sets for 1932 and 1933 were only fair, the population at present is largely composed of the 1929, 1930 and 1931 year classes. Many of the clams of the 1929 and 1930 sets have reached legal size, and the 1931 group is approaching this size. For this reason legal sized clams have been more easily obtained during the past season. Commercial diggers, operating on the sand bars in the surf, have secured limits without great difficulty. But the census indicated that, as in former years, practically no legal sized clams were to be found in the open area on the beach above the lowest tide line. In the closed area, 7 per cent of the clams were above legal size.

More adequate protection has checked the former rapid mortality rate of clams below the 5-inch size limit. However, in the open area, as each year class attains legal size its numbers decrease alarmingly. On the other hand, the increase in the numbers of legal sized clams in the closed area indicates that this form of protection builds up the

total clam population, whereas a size limit without closure to all digging merely protects the clams to a certain size but does not accumulate any reserve spawners. To build up the Pismo clam population to something like its former magnitude the entire Pismo Beach should be closed to all digging for a period of years. If this closure could be effected now when large numbers of the 1929, 1930 and 1931 year classes have attained and are attaining maturity, the success of the closure would soon be assured. The only alternative to complete closure of the beach is an increase in the size limit to 5¾ inches. This would protect each year class through several spawning seasons and create a more adequate spawning reserve. The present 5-inch limit does not and can not do this. Without complete closure or a drastic increase in the present size limit, the abundant year classes of 1929, 1930 and 1931 will soon be wiped out and the population again reduced to the dangerously low level of 1927 and 1928, or perhaps lower.—*Frances N. Clark, California State Fisheries Laboratory, November, 1934.*

SARDINE FISHING OPERATIONS TO THE SOUTH OF MONTEREY

During the 1934-1935 sardine season in the Monterey region, a number of boats again conducted fishing operations south of Monterey Bay to Pfeiffer's Point, some six miles south of Point Sur and about twenty-eight miles south of Monterey. The first definite southward expansion into this area was during the 1933-1934 season, when a number of boats made catches mainly between Point Sur and Pfeiffer's Point. In the season of 1934-1935, catches in the southern area were more widely scattered between Point Pinos and Pfeiffer's Point. Although a greater number of boats scouted this southern area during the 1934-1935 season, the tonnage landed from this area during the past season was not as great as for the 1933-1934 season.—*J. B. Phillips, California State Fisheries Laboratory, March 6, 1935.*

RECORD LOAD OF SARDINES

On December 20, 1933, the purse seine boat *Geneva* established a record by delivering 154 tons of sardines to the California Packing Corporation plant at East San Pedro. On January 7, 1935, the purse seiner *Bremen* broke this record by unloading 166.6 tons at the cannery of the Franco-Italian Packing Company of East San Pedro. Again on February 11, 1935, the *Bremen* carried a record load of sardines, estimated at 180 tons for delivery to the Franco-Italian Packing Company.

A dozen years ago a 60-ton load of sardines was considered huge, but since then there has been a period of expansion in which canning and reduction plant capacities have been greatly enlarged, and the former fleet of small fishing boats has been almost entirely replaced by larger boats of greater cruising radius and greatly increased carrying capacities. Sardines occur in large schools so that when a school is located the size of the boat catch depends largely upon the hold capacity of the fishing vessel. Because a large boat can carry more fish than a small one is no indication that sardines are more plentiful than they were a dozen years ago. Not only are individual boats larger than in past years, but there are also more boats fishing sardines now so that the total catch has increased as the direct result of the increase in fishing effort.—*W. L. Scofield, California State Fisheries Laboratory, February, 1935.*

CHARTERED PURSE SEINE BOATS IN THE MONTEREY SARDINE FISHERY

During the 1934-1935 sardine season, 64 purse seine and 23 launch and lighter boats delivered fish at Monterey. Of the purse seine boats, 20 were locally owned, 8 were from southern California, 2 from San Francisco, and 34 from Washington. All of the Washington boats except one and one of the San Francisco boats were chartered by local fishermen.

The number of these chartered boats in the 1934-1935 season was twice that for 1933-1934, when this practice started. The common arrangement in 1934-1935 was for the owner of a chartered boat to charge 4 shares of the boat's earnings for the boat and an additional $3\frac{1}{2}$ shares for the use of the net. However, practically all of the charterers made up their own nets. A few of the local charterers did not work with the boat, and in this case one of the crew was appointed captain and given an extra half share. The northern boat owners also specified that at least four of the original crew, including the captain and engineer, accompany the boat and work with it, participating in the earnings as regular crew members. In a few cases, a majority of the original crew accompanied the boat, but in most cases usually only four of the original crew. A standard crew on a purse seine boat that fishes sardines in the Monterey region is 11 men. The owner also required the charterer to pay for insurance while the boat was away from its home port.—*J. B. Phillips, California State Fisheries Laboratory, March 6, 1935.*

CANNERY BEING BUILT AT MOSS LANDING

During February, 1935, the Hovden Food Products Company commenced construction work on a fish cannery at Moss Landing on Monterey Bay. Plans are for a small 3 or 4 line canning plant to produce fancy-pack, small sardines. Mackerel may also be packed in the future. It is hoped to have the plant completed by May 1, 1935. This plant will probably only be in operation between the months of May and October, or during the time that water conditions will permit unloading in the open bay. Unloading will take place over the wharf, and the fish will be transported to the plant over narrow gauge tracks.—*J. B. Phillips, California State Fisheries Laboratory, March 6, 1935.*

THE PACIFIC HALIBUT FISHERY

The International Fisheries Commission, created by a treaty in 1924 between the United States and Great Britain for the conservation of the halibut fishery of the Northern Pacific Ocean, recently issued their eighth report.[*]

The first part of the paper is a brief review of the work and publications of the Commission since its formation, including regulations imposed on the fishery and the results of same, relative depletion of

[*] Thompson, William F., and Bell, F. Heward. Biological statistics of the Pacific halibut fishery: (2) Effect of changes in intensity upon total yield and yield per unit of gear. Intern. Fish. Comm. Report, No. 8, 49 pp., 18 figs., 1934.

different fishing banks, results of marking experiments, growth studies, egg and larval work, and collection and use of statistics.

Statistics include the total catch, which is easily obtained from the actual landings. Of equal importance and far harder to get is the catch per unit of fishing effort. This is obtained from log books which are given to the fishermen and in which are recorded the catch and number of hooks used each day. By carefully explaining what they are doing and why, the Commission has been able to get splendid cooperation from the fishermen, over 80 per cent of the halibut landed is recorded in *usable* log books.

Results of current studies, egg and larval work, and the tagging of about 13,000 fish have shown that the halibut fishery must be divided into four major areas. These are: No. 1, south of Willapa Bay (about opposite Seattle); No. 2, Willapa Bay to Cape Spencer (just outside Juneau); No. 3, west of Cape Spencer; and No. 4, Bering Sea. Areas 1 and 4 are not important. Area 2 has been so heavily fished that it contains mostly immature fish, but Area 3 still has a majority of adult stock. Immature fish migrate very little; adults migrate widely within an area but seldom stray from one area into another.

Of great interest are the results of the Commission's regulations, which were put into effect in 1931. These regulations limited the total amount of fish which could be taken from each area and closed a few banks which contained nothing but small fish. The results have been that although the total catch has remained constant, the *catch per unit of effort has increased 50 per cent* on the grounds closer to Seattle (Area 2). This was done in a region where the total catch had been declining rapidly since 1912 and the catch per unit of effort had been declining far more rapidly since the first figures were given in 1907. There has been a similar but less marked improvement west of Cape Spencer.

The second part of the paper deals with the effect of the fishery upon yield and reproduction. First taken up is the effect of different fishing intensities upon the production of spawn. The fishermen begin taking the halibut when they are four years old and the fish do not mature until they are eight. If fishing is heavy comparatively few fish live long enough to spawn. The authors go into this quantitatively and show the relative differences in egg production under different conditions. A small difference in fishing intensity will produce a far larger difference in egg production. For example, assume that fishing and natural causes kill 58 per cent of the fish each year: If this mortality is decreased from 58 to 44 per cent, the egg yield will be increased six times. In the heavily fished areas, spawn is very scarce at the present time.

Next discussed is the way to get the greatest possible yield out of a fishery *disregarding egg production*. If the growth rate of a species is fairly high and the natural death rate is low, the fish which survive each year, though fewer in number, may weigh more in the aggregate than they and their "deceased brethren" did the previous year. Obviously, under such circumstances, more weight of fish can be obtained by letting a larger number survive each season. To learn whether or not this is the case, it is necessary to know the natural death rate. Thompson and Bell then show how to determine approxi-

mately this important figure. They first show how to calculate total catch and catch per unit of effort under different fishing intensities when the mortality rate is known. Then they use their actual figures on total catch, catch per unit of effort and fishing intensity and work backwards to obtain the mortality rate. They conclude that on the grounds nearer Seattle, a *lower fishing intensity should produce a higher yield* even if egg production is disregarded. They are unable to say whether or not this holds true on the more northern grounds.

The report represents a magnificent piece of work, and the only regret is that the methods cannot be applied to fisheries where there is no satisfactory way of measuring the fishing effort.—*D. H. Fry, Jr., California State Fisheries Laboratory, November 17, 1934.*

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR OCTOBER, NOVEMBER AND DECEMBER, 1934

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species of fish	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	92,487	122,909	215,396
Cabrilla	12,423	14,873	27,296
Corbina, Mexican	6,343		6,343
Cultus, Pacific	84		84
Grouper	1,215	1,721	2,936
Halibut, California	32,396	76,583	108,979
Herring, Pacific		2,750	2,750
Perch	51		51
Mackerel, Pacific		2,223	2,223
Mackerel, Spanish	1,907	2,463	4,370
Rock Bass	4,561	6,239	10,800
Rockfish	90	68,089	68,179
Sablefish		774	774
Sardine		1,588	1,588
Sea-bass, Black	166,424	168,840	335,264
Sea-bass, White	17,522	13,095	30,617
Shark		2,540	2,540
Sheepshead	226	716	942
Smelt	132	148	280
Sole		3	3
Swordfish, Broadbill		163	163
Totuava	253,618	5,320	258,938
Tuna, Albacore	821,251		821,251
Tuna, Bluefin	678	23,600	24,278
Tuna, Bonito	10,724	68,701	79,425
Tuna, Skipjack	1,636,086	4,626,983	6,263,069
Tuna, Yellowfin	2,931,243	13,754,318	16,685,561
Whitefish	1,625	8,933	10,558
Yellowtail	418,007	261,859	679,866
Miscellaneous fish	614		614
Crustacean:			
Lobster, Spiny		232,155	232,155
Reptile:			
Turtle		140	140
Total pounds	6,409,707	19,467,726	25,877,433

* This poundage included in tables of landings for Region 70, Los Angeles, and Region 80, San Diego.

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN. OCTOBER, NOVEMBER AND DECEMBER, 1934

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species of fish	Gulf of California	West coast Lower California	International waters south U. S. boundary (definite origin unknown)	Mexican mainland and Central America	Japan	Total pounds
Barracuda		22,824	192,572			215,396
Cabrilla	6,550	2,759	17,882	105		27,296
Corbina, Mexican	6,343					6,343
Cultus, Pacific			84			84
Grouper			2,936			2,936
Halibut, California			108,979			108,979
Herring, Pacific			2,750			2,750
Perch			51			51
Mackerel, Pacific			2,223			2,223
Mackerel, Spanish		1,144	3,226			4,370
Rock Bass			10,800			10,800
Rockfish			68,179			68,179
Sablefish			774			774
Sardine			1,588			1,588
Sea-bass, Black		36,579	298,685			335,264
Sea-bass, White		3,935	26,682			30,617
Shark			2,540			2,540
Sheepshead			942			942
Smelt			280			280
Sole			3			3
Swordfish, Broadbill			163			163
Totuava	258,938					258,938
Tuna, Albacore					821,251	821,251
Tuna, Bluefin			24,278			24,278
Tuna, Bonito		4,137	75,288			79,425
Tuna, Skipjack		763,547	4,786,983	58,407	654,132	6,263,069
Tuna, Yellowfin		415,369	14,269,006	1,932,686	68,500	16,685,561
Whitefish			10,558			10,558
Yellowtail		206,104	473,762			679,866
Miscellaneous fish		100	514			614
Crustacean:						
Lobster, Spiny		232,155				232,155
Reptile:						
Turtle			140			140
Total pounds	271,831	1,688,653	20,381,868	1,991,198	1,543,883	25,877,433

CALIFORNIA FRESH FISH LANDINGS* FOR OCTOBER, NOVEMBER AND DECEMBER, 1934

Compiled by Division of Fish and Game, Bureau of Commercial Fisheries

Species of fish	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy				3,350	260		1,060		4,670
Barracuda						3,907	110,076	128,157	242,200
Cabrilla							12,423	14,873	27,296
Carp			44,450				20,960		65,410
Catfish			82,170						82,170
Corbina, Mexican							6,343		6,343
Cultus, Pacific	2,211	14,755		125,623	33,152	30	103		175,874
Flounder, Starry		1,901		15,350	1,618	55			18,927
Flying Fish							1,262		1,262
Grouper							1,215	1,721	2,936
Hake				27,226			99		27,325
Halibut, California				3,471	3,583	72,830	77,441	76,756	234,081
Halibut, Northern	432	56,816		14,258					71,506
Hardhead			20,663						20,663
Herring, Pacific				353,848	5,115	360		27,770	387,093
Kingfish				8,731	80,277	50	84,408	2,560	176,026
Mackerel, Horse					72,264		989,047	1,549	1,062,860
Mackerel, Pacific				3,688	1,358,941	6,202	34,258,569	480,995	36,108,395
Mackerel, Spanish							1,907	2,463	4,370
Mullet							1,117	262	1,379
Perch		499		23,747	35	558	28,460	290	53,589
Pike			162						162
Pompano, California							691		691
Rock Bass						914	36,860	48,390	86,164
Rockfish	3,712	16,539		252,161	422,214	61,046	207,805	97,925	1,061,402
Sablefish	311	242,688		75,554	236,159		61,400	774	616,886
Salmon			40						40
Sand Dab				87,932	2,888		2,587		93,407
Sardine			70,021,151	14,318,430	256,628,318	40	126,218,320	1,071,868	468,258,127
Sculpin						537	12,758	622	13,917
Sea-bass, Black						230	168,768	168,840	337,838
Sea-bass, White				127	21	9,772	44,310	13,779	68,009
Shark	45			29,346		1,139	69,365	4,016	103,911
Sheepshead						11,527	53,523	3,133	68,183
Skate				44,809	706		1,773		47,288
Smelt		2,135		30,777	43,659	2,368	81,270	3,901	164,110
Sole				2,066,497	2,997	156,534	2,192	141	2,228,361
Split-tail			15,011						15,011
Sucker			21,702						21,702

Swordfish, Broadbill						6,310	40,558	660	47,528
Swordfish, Marlin							4,804		4,804
Tomcod				30					30
Totuava							253,618	5,320	258,938
Tuna, Albacore							821,422		821,422
Tuna, Bluefin						87	298,726	31,342	330,155
Tuna, Bonito						31	35,193	71,400	106,624
Tuna, Skipjack							1,636,086	4,626,983	6,263,069
Tuna, Yellowfin							2,931,355	13,754,812	16,686,167
Turbot				8,861			2		8,863
Whitebait				2,792	13				2,805
Whitefish						546	13,211	10,878	24,635
Yellowtail						27	425,806	266,635	692,468
Miscellaneous fish		458		44,339		8	3,291		48,096
Crustacean:									
Crab	16	4,212		818,904	90,384				913,516
Crab, Rock							5,548		5,548
Lobster, Spiny						54,992	110,807	265,460	431,259
Prawn					239				239
Shrimp				305,910					305,910
Mollusk:									
Abalone					700,675	131,800	492		832,967
Clam, Cockle				12,649			4,604	48	17,301
Clam, Gaper		408		166					574
Clam, Pismo					9,789	24,582			34,371
Clam, Soft-shell				48,413					48,413
Clam, Washington		13,177		296					13,473
Octopus		209		1,509	1,476		28		3,222
Oyster, Eastern				247,249					247,249
Oyster, Native				1,189					1,189
Squid					694,005		8		694,013
Reptile:									
Turtle								140	140
Total pounds	6,727	353,800	70,205,349	18,977,232	260,388,788	546,542	169,141,671	21,184,463	540,804,572

* Fresh fish importations from foreign countries included in this table. See importation tables.

STATEMENT OF EXPENDITURES

For the Period July 1, 1934, to December 31, 1934, of the Eighty-sixth Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Administration:					
Executive	$4,134 26				$4,134 26
Clerical and office	2,760 00	$308 34	$99 03	$15 00	3,182 37
Printing, general		2,165 51			2,165 51
Automobiles		188 83	297 27		486 10
Traveling			1,248 77		1,248 77
Postage			2,259 91		2,259 91
Telephone and telegraph			1,478 94		1,478 94
Freight, cartage and express			324 79		324 79
Rent			5,474 73		5,474 73
Accident and death claims			3,921 16		3,921 16
Accounting pro rata	2,286 13				2,286 13
Legal			1,011 25	8 00	1,019 25
Premiums on bonds			15 00		15 00
Publicity			921 39		921 39
Total Administration	$9,180 39	$2,662 68	$17,052 24	$23 00	$28,918 31
Bureau Education and Research:					
Clerical and office	$960 00		$22 63		$982 63
Automobiles		$311 29	72 95		384 24
Traveling			758 22		758 22
Photography		11 84	45 39		57 23
Library	540 00	5 08	37 07	$26 04	608 19
Research	1,800 00	76 30	37 25		1,913 55
Publicity	1,381 84		34 05		1,415 89
Total Bureau Education and Research	$4,681 84	$401 51	$1,007 56	$26 04	$6,119 95
Bureau Patrol and Law Enforcement:					
Chief and assistants	$5,550 00				$5,550 00
Clerical and office	1,590 00	$13 41	$61 00	$30 00	1,694 41
Automobiles		12,603 75	6,728 85	3,568 78	22,901 38
Traveling			21,751 15		21,751 15
Postage			300 07		300 07
Telephone and telegraph			850 73		850 73
Freight, cartage and express			6 45		6 45
Rent			310 88		310 88
Captains and wardens	92,620 64	218 63	557 67		93,396 94
Launches		825 15	617 43	310 27	1,752 85
Fish planting	2,310 00	456 30	1,609 17	12 19	4,387 66
Premiums on bonds			232 50		232 50
Cooks	750 00				750 00
Commercial fisheries patrol:					
Chief	1,380 00				1,380 00
Captains and wardens	6,727 10	3 35	5 00	12 52	6,747 97
Launches	5,820 98	2,026 45	1,669 32	149 92	9,730 67
Fish cannery inspectors, seasonal	4,239 47				4,239 47
Traveling			2,437 15		2,437 15
Rent			396 00		396 00
Automobiles		343 78	293 35		637 13
Temporary help	237 92				237 92
Total Bureau Patrol and Law Enforcement	$121,226 11	$16,560 82	$37,826 72	$4,083 68	$179,697 33
Bureau Commercial Fisheries:					
Chief and assistants	$6,810 00				$6,810 00
Clerical and office	4,800 00	$44 29	$11 95	$15 00	4,871 24
Automobiles		257 61	155 64		413 25
Traveling			2,663 07		2,663 07
Telephone and telegraph			296 42		296 42
Freight, cartage and express			52 84		52 84
Rent			72 70		72 70
Heat, light, water and power			154 42		154 42
Research	1,140 00	12 72		3 08	1,155 80
Laboratory	11,520 00	292 22	302 79	80 22	12,195 23
Statistics		436 68	1,201 00		1,637 68
Temporary help	75 87				75 87
Total Bureau Commercial Fisheries	$24,345 87	$1,043 52	$4,010 83	$98 30	$30,398 52

STATEMENT OF EXPENDITURES

For the Period July 1, 1934, to December 31, 1934, of the Eighty-sixth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Bureau Fish Culture:					
Chief and assistants	$3,630 00	$2 89	$5 00		$3,637 89
Clerical and office	2,520 00	12 90			2,532 90
Automobiles		4,021 52	1,851 82	$2,620 88	8,503 22
Traveling			4,770 39		4,770 39
Postage			106 04		106 04
Telephone and telegraph			486 14		486 14
Freight, cartage and express			392 79		392 79
Rent			2,228 00		2,228 00
Heat, light and power			889 54		889 54
Hatcheries	53,874 49	28,238 22	313 46	532 59	82,958 76
Fish cars	1,770 00	231 81	2,081 89		4,083 70
Blue printing			33 66		33 66
Cooperative research	778 39	407 97	500 57	168 50	1,855 43
Temporary help	294 00				294 00
Fish hatchery assistants, seasonal	11,679 16				11,679 16
Hydraulic engineering	1,200 00	6 25	499 62	3 26	1,709 13
Special field	3,669 96	28 80	4 65	13 72	3,717 13
Fish rescue:					
Miscellaneous supplies		47 18		5 98	53 16
Heavy truck mileage			336 51		336 51
Travel			729 43		729 43
Rent and water service			25 00		25 00
Motorized equipment		69 37	4 00	551 25	624 62
Chief and assistants	1,290 00		235 53		1,525 53
Total Bureau Fish Culture	$80,706 00	$33,066 91	$15,494 04	$3,905 18	$133,172 13
Bureau Game Propagation:					
Chief and assistants	$2,730 00				$2,730 00
Clerical and office	420 00				420 00
Automobiles		$607 31	$251 98	$963 66	1,825 95
Traveling			932 24		932 24
Postage			11 04		11 04
Telephone and telegraph			104 30		104 30
Freight, cartage and express			4 15		4 15
Heat, light, water and power			1,064 44		1,064 44
Maintenance	5,802 00	4,213 23	134 40	4 55	10,154 18
Temporary help	33 55				33 55
Quail trapping and expansion of quail program	2,310 00	541 91	1,448 89	10 55	4,311 35
Purchase of quail and pheasants		3,728 62			3,728 62
Refuge maintenance	846 00				846 00
Total Bureau Game Propagation	$12,141 55	$9,091 07	$3,954 44	$978 76	$26,165 82
Bureau Game Refuges:					
Chief and assistants	$4,249 98				$4,249 98
Clerical and office	960 00	$11 83	$11 50		983 33
Automobiles		266 43	168 67		435 10
Traveling			2,203 93		2,203 93
Freight, cartage and express			7 26		7 26
Blue printing			4 18		4 18
Lion hunters	2,711 00				2,711 00
Refuge posting	450 00				450 00
Predatory animal control			2,570 00		2,570 00
Refuge maintenance	4,075 32	993 42	438 73	$115 51	5,622 98
Predatory animal hunters and trappers, seasonal	3,000 00				3,000 00
Temporary help, seasonal	1,939 00				1,939 00
Total Bureau Game Refuges	$17,385 30	$1,271 68	$5,404 27	$115 51	$24,176 76
Bureau Licenses:					
Clerical and office	$6,570 00	$68 09	$12 95	$6 66	$6,657 70
Printing, licenses and applications		280 89			280 89
Traveling			398 60		398 60
Postage			782 18		782 18
Freight, cartage and express			50 77		50 77
Premium on bonds			938 25		938 25
Total Bureau Licenses	$6,570 00	$348 98	$2,182 75	$6 66	$9,108 39
Total eighty-sixth fiscal year expense paid from support appropriations	$276,237 06	$64,450 17	$87,532 85	$9,237 13	$437,757 21

STATEMENT OF EXPENDITURES

For the Period July 1, 1934, to December 31, 1934, of the Eighty-sixth Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Prior Year Expense for Support, Eighty-fifth Fiscal Year					$17,322 24
Total Eighty-fifth and Eighty-sixth Fiscal Year Expense Paid From Support Appropriations					$455,079 45
Special Items:					
Eighty-sixth fiscal year:					
License commissions			$23,095 50		$23,095 50
Construction of Russian River jetties, Chapter 989-33			109 16		109 16
Total Eighty-sixth Fiscal Year			$23,204 66		$23,204 66
Eighty-fifth Fiscal Year:					
License commissions				$315 65	
Construction of Russian River jetties, Chapter 989-33				30 00	
Total Eighty-fifth Fiscal Year					$345 65
Total Special Items					$23,550 31
Permanent Improvements:					
Construction, Improvements and Equipment:					
Eighty-sixth fiscal year	$4,602 50	$3,487 20	$7,599 48	$1,616 58	$17,305 76
Eighty-fifth fiscal year					34 44
Total Permanent Improvements					$17,340 20
Bureau of Commercial Fisheries—Chapter 825-33—					
Fresh Fish Marketing:					
Eighty-sixth Fiscal Year:					
Chief and assistants	$2,906 03				$2,906 03
Clerical and office	660 00				660 00
Printing		$203 21			203 21
Automobiles			$23 74		23 74
Traveling			1,059 22		1,059 22
Postage			170 00		170 00
Telephone and telegraph			1 35		1 35
Freight, cartage and express			278 79		278 79
Rent			38 56		38 56
Exhibits					2,230 51
Temporary help	100 50	235 14	1,995 37		100 50
Total Eighty-sixth Fiscal Year	$3,666 53	$438 35	$3,567 03		$7,671 91
Eighty-fifth Fiscal Year					$5 37
Total Bureau of Commercial Fisheries—Chapter 825-33—Fresh Fish Marketing—Eighty-fifth and Eighty-sixth Fiscal Years					$7,677 28
Total from Current Biennium					$503,647 24
Prior Biennium Appropriations:					
Eighty-fifth Fiscal Year:					
Permanent Improvements:					
Construction, improvements and equipment					$583 19
Eighty-fourth fiscal year:					
Support					$53 65
Total from Prior Biennium Appropriations					$270 46
Grand Total Proprietary Group					$503,917 70

STATEMENT OF INCOME

For the Period July 1, 1934, to December 31, 1934, of the Eighty-sixth Fiscal Year

Revenue for the Fish and Game Preservation Fund, Current Year:

License sales:	Detail	Total
Angling licenses, 1934	$151,947 50	
Commercial hunting club licenses, 1934-35	1,225 00	
Commercial hunting club operators' licenses, 1934-35	265 00	
Deer tags, 1934	94,736 00	
Fish breeders' licenses, 1934	25 00	
Fish importers' licenses, 1934	35 00	
Fish packers' and wholesale shell fish dealers' licenses, 1934-35	800 00	
Game breeders' licenses, 1934	115 00	
Hunting licenses, 1933-34	3,031 50	
Hunting licenses, 1934-35	158,855 50	
Kelp licenses, 1934	20 00	
Market fishermen's licenses, 1934-35	27,220 00	
Trapping licenses, 1934-35	1,210 00	
Total license sales		$440,451 50
Other income:		
Court fines	$18,555 60	
Dividends California National Bank	7,415 03	
Dividends Trinity County Bank at Weaverville	71 00	
Fish packers' tax	133,486 65	
Fish tag sales	1,471 55	
Game tag sales	103 71	
Importers' contributions	155 00	
Interest on bank balances	3,543 12	
Kelp tax	45 99	
Lease of kelp beds	1,025 60	
Miscellaneous sales	153 83	
Publication sales	268 60	
Total other income		$166,298 68
Total current year		$606,750 18

SEIZURES OF FISH AND GAME

October, November, December, 1934

Fish:	
Abalones	307
Bass, Striped	119
Bass, Striped, pounds	303
Bass, Black	14
Catfish, pounds	17
Clams	1,988
Lobsters	859
Perch	20
Salmon, pounds	236
Trout	8
Yellowfin, pounds	17,139
Fish traps	8
Game:	
Deer	20
Deer hides	8
Deer meat, pounds	365
Ducks, geese, mudhens	237
Doves	59
House linnets, pounds	36
Non-game birds	33
Pheasants	25
Pigeons	36
Quail	151
Rabbits	2
Swan	1
Shorebirds	15
Tree squirrels	3
Guns	4

GAME CASES

October, November, December, 1934

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer; closed season; killing of does, fawns, spiked bucks; failure to tag	81	$2,193 00	816
Ducks; geese; mudhens; closed season; overlimit	21	835 00	
Doves, closed season	3	225 00	
Grouse, closed season	1	10 00	
Hunting without license	83	929 50	110
Non-game birds; killing of	9	170 00	
Night hunting	31	472 50	75
Pheasants; closed season	19	282 50	
Pigeons; closed season	2	50 00	
Quail; closed season	7	130 00	
Rabbits; closed season	7	85 00	
Tree squirrels; closed season	1	100 00	
Shorebirds; killing of	7	125 00	
Swan; killing of	1	12 50	
Spotlight hunting	19	525 00	
Shooting from auto or motor boat	13	150 00	
Hunting in refuge	5	20 00	
Trespassing on posted land	7	45 00	
Miscellaneous game cases	5	45 00	
Totals	322	$6,405 00	1,001

FISH CASES

October, November, December, 1934

Offense	Number arrests	Fines imposed	Jail sentences (days)
Angling; no license	23	$145 00	30
Abalones; small, overlimit	26	770 00	221
Bass, striped; overlimit and small	27	562 50	
Commercial Fishing License Act; violations of	53	165 00	25
Clams; small; overlimit	62	962 50	120
Catfish; small	1	25	
Lobsters; small	23	335 00	37
Night fishing	19	70 00	35
Pollution	6	350 00	
Perch; overlimit	1	50 00	
Salmon; illegal taking of	9	150 00	
Illegal fishing apparatus	5	35 00	
Fishing near fishway	1	25 00	
Trout; overlimit	3	75 00	
Nets, seines; illegal use of	11	300 00	215
Fish traps; illegal	3	120 00	
Miscellaneous fish cases	4	110 00	
Totals	277	$4,250 00	683

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BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol — San Francisco
K. P. Allred, Assistant Chief of Patrol — San Francisco
C. S. Bauder, Assistant Chief of Patrol — Los Angeles

SAN FRANCISCO OFFICE

C. L. Bundock — Oakland
T. K. Duncan — Concord
C. E Holladay — San Jose
M. F. Joy — San Francisco
McPherson Lough — Palo Alto
Forrest J. McDermott — Santa Cruz
C. R. Peek — San Mateo
Orben Philbrick — Monterey
Fred Post — Salinas
Lee C. Shea — San Francisco
Geo. Smalley — Monterey
J. P. Vissiere — Watsonville
L. T. Ward — Alameda

WM. LIPPINCOTT — San Rafael
W. J. Black — Vallejo
C. M. Bouton — San Rafael
Ed Clements — Fairfield
Chas. F. England — Vallejo
Bert F. Laws — Inverness
Tate F. Miller — San Rafael
H. S. Vary — Antioch
R. J. Yates — San Rafael

A. H. WILLARD — Sacramento Office
Earl I. Hiscox — Grass Valley
Nelson Poole — Sacramento Office
Albert W. Sears — Placerville
Chas. Sibeck — Sacramento Office
R. L. Sinkey — Woodland

W. J. HARP — Arcata
W. C. Blewett — Crescent City
E. R. Caldwell — Eureka
Scott Feland — Fortuna
Ed Johnson — Garberville
W. F. Kaliher — Fortuna

S. R. GILLOON — Mt. Shasta
Brice Hammack — Yreka
A. A. Jordan — Alturas
Paul Kehrer — Fall River Mills
C. R. Love — Redding
Fred Starr — Macdoel

S. J. CARPENTER — Maxwell
Roy W. Anderson — Red Bluff
Lee Atkinson — Willows
L. W. Dinsdale — Yuba City
R. J. Little — Gridley
Taylor London — Oroville
E. O. Wraith — Chico

J. D. DONDERO — Lakeport
Ray Diamond — Willits
Ovid Holmes — Fort Bragg
Geo. N. Johnson — Napa
Earl Macklin — Ukiah

L. A. Mitchell — Point Arena
K. J. Ransdell — Lakeport

HENRY LENCIONI — Santa Rosa
J. H. Groves — Cloverdale
V. E. Vox Arx — Santa Rosa

JOSEPH H. SANDERS — Truckee
C. O. Fisher — Susanville
C. L. Gourley — Westwood
L. E. Mercer — Quincy
Alvin Granstrom — Portola

J. E. NEWSOME — Newman
H. E. Black — Madera
C. L. Brown — Mariposa
M. S. Clark — Merced
L. W. Longeway — Sonora
Geo. W. Magladry — Modesto
R. A. Tinnin — Newman

J. O'CONNELL — Stockton
Wm. Hoppe — Lodi
Vernon Sutton — Angels Camp
J. W. Thornburg — Markleeville

E. W. SMALLEY — Hanford
F. A. Bullard — Reedley
Ray Ellis — Fresno

O. P. BROWNLOW — Visalia
Lester Arnold — Bakersfield
Ray J. Bullard — Porterville
W. I. Long — Woodlake
Roswell C. Welch — Kernville

LOS ANGELES OFFICE

A. R. Ainsworth — Santa Maria
R. E. Bedwell — Ventura
A. F. Crocker — Bridgeport
G. S. Donham — Pismo Beach
E. H. Glidden — San Diego
J. H. Gyger — Perris
J. W. Harbuck — Brawley
W. L. Hare — Santa Ana
F. W. Hecker — San Luis Obispo
H. C. Jackson — Santa Barbara
T. R. Jolley — Idyllwild
E. H. Ober — Palmdale
W. S. Talbott — Fallbrook
C. L. Towers — Los Angeles
Paul Turner — Paso Robles
Eugene Walker — Independence
C. J. Walters — Independence
R. O'Conner — Blythe

LARUE F. CHAPPELL — Pasadena
W. C. Malone — San Bernardino
C. L. Savage — Ontario

COMMERCIAL FISHERIES PATROL

S. H. LYONS, Supervisor Fisheries Patrol — Terminal Island
C. H. GROAT, Captain — Terminal Island
R. F. CLASSIC, Captain — Monterey
N. C. Kunkel — Terminal Island
T. W. Schilling — San Diego
T. J. Smith — Terminal Island
A. Robertson — Terminal Island

Launch Patrol

Walter Engelke — Motor Vessel "Bluefin," Terminal Island
L. J. Weseth — Launch "Albacore," Monterey
Erol Greenleaf — Launch "Albacore," Monterey
C. M. Bouton — Launch "Quinnat," San Rafael
W. J. Black — Launch "Hunter," Vallejo
Wm. Hoppe — Launch "Rainbow," Walnut Grove
W. J. Harp — Launch "Silverside," Eureka

Captains indicated in capitals.